Dissertation on

# A STUDY ON FACIAL ARTERY AND ITS SUBMENTAL AND PERIORAL BRANCHES

Submitted in partial fulfillment for

**M.D. DEGREE EXAMINATION**

**BRANCH- XXIII , ANATOMY**

**Upgraded Institute of Anatomy**

**Madras Medical College & Research Institute,**

**Chennai- 600 003**


**THE TAMILNADU Dr.M.G.R. MEDICAL UNIVERSITY**

**CHENNAI – 600 032**

**TAMILNADU**

**APRIL 2015**

# CERTIFICATE

This is to certify that this dissertation entitled **" A STUDY ON FACIAL ARTERY AND ITS SUBMENTAL AND PERIORAL BRANCHES "** is a bonafide record of the research work done by **Dr. B J. BHUVANESWARI** Post graduate in the Institute of Anatomy, Madras Medical College and Research Institute, Government General Hospital,Chennai-03, in partial fulfillment of the regulations laid down by The Tamil Nadu Dr.M.G.R. Medical University for the award of M.D. Degree Branch XXIII- Anatomy, under my guidance and supervision during the academic year from 2012-2015.

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# INSTITUTIONAL ETHICS COMMITTEE
# MADRAS MEDICAL COLLEGE, CHENNAI-3

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## CERTIFICATE OF APPROVAL

To
Dr. B.J. Bhuvaneswari,
PG in Anatomy,
Institute of Anatomy,
Madras Medical College, Chennai-3.

Dear Dr. B.J. Bhuvaneswari,

The Institutional Ethics Committee of Madras Medical College, reviewed and discussed your application for approval of the proposal entitled **"Study on Facial artery and its Submental and Perioral Branches"** No.13032014

The following members of Ethics Committee were present in the meeting held on 11.03.2014 conducted at Madras Medical College, Chennai-3.

| | | |
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| 2. | Dr. R. Vimala, M.D.<br>Dean, MMC, Ch-3. | -- Deputy Chairperson |
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| 8. | Tmt. Arnold Saulina, MA MSW | -- Social Scientist |
| 9. | Thiru. S. Ramesh Kumar,<br>Administrative Officer, MMC, Ch-3. | -- Layperson |

We approve the proposal to be conducted in its presented form.

Sd/Chairman & Other Members

The Institutional Ethics Committee expects to be informed about the progress of the study, and SAE occurring in the course of the study, any changes in the protocol and patients information / informed consent and asks to be provided a copy of the final report.

2/4/14

Member Secretary, Ethics Committee

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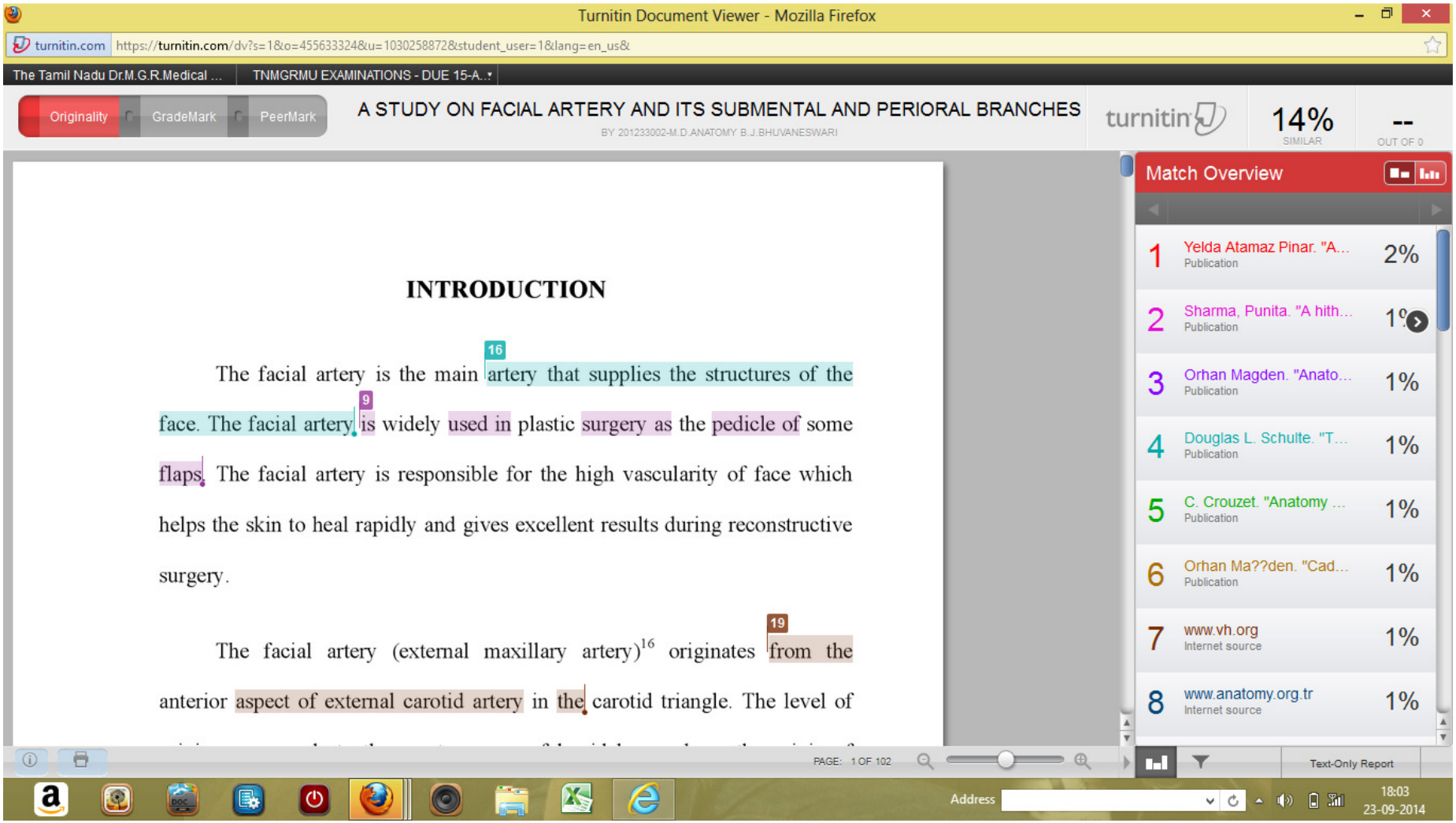
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INTRODUCTION
The facial artery is the main artery that supplies the structures of the face. The facial artery is widely used in plastic surgery as the pedicle of some flaps. The facial artery is responsible for the high vascularity of face which helps the skin to heal rapidly and gives excellent results during reconstructive surgery.
The facial artery (external maxillary artery)[16] originates from the anterior aspect of external carotid artery in the carotid triangle. The level of
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I'm grateful to my husband**, Mr Ranjith,** my children **Atul , Aadhav** and my parents- in-law**, Mr Chinnappa and Mrs Meenakshi** who have helped making this study a reality.

Above all, I thank the **ALMIGHTY GOD** who has showered His choicest blessings on me and guided me in every step of the dissertation.

# LEGEND

| | | |
|---|---|---|
| AA | - | Angular Artery |
| BA | - | Buccal Artery |
| CB | - | Carotid Bifurcation |
| CCA | - | Common Carotid Artery |
| CLF | - | Common Linguo Facial |
| ECA | - | External Carotid Artery |
| FA | - | Facial Artery |
| IAA | - | Inferior Alar Artery |
| ILA | - | Inferior Labial Artery |
| LA | - | Lingual Artery |
| LNA | - | Lateral Nasal Artery |
| MA | - | Mandibular Angle |
| MM | - | Mandibular Margin |
| OC | - | Oral Commissure |
| PMA | - | Pre-Masseteric Artery |
| SAA | - | Superior Alar Artery |
| SLA | - | Superior Labial Artery |
| SMA | - | SubMentalArtery |
| SMG | - | SubMandibular Gland |
| STA | - | Superior Thyroid Artery |

# CONTENTS

# A STUDY ON FACIAL ARTERY AND ITS SUBMENTAL AND PERIORAL BRANCHES

The main arterial supply of the facial skin envelope is the facial artery which serves as a main pedicle for a number of facial flaps. The knowledge of anatomy of facial artery is essential in raising viable facial flaps and devising new flaps.Therapeutic radiological interventions like embolization of tumour feeding vessel in case of tumours of face need a thorough knowledge of the vascular pattern of face.

The anatomy of the facial artery was studied in 50 adult head and neck specimens at the Institute of Anatomy, Madras Medical College. Facial artery in 15 adult carotid angiograms from the Barnard Institute of Radiology, Rajiv Gandhi Government General Hospital were also studied.

Facial artery arose separately from the external carotid artery in 82 % of specimens and 93.33 % of angiograms. Common linguo facial trunk was present in 18 % of specimens and 6.66 % of angiogram. The branching pattern of facial artery in face was classified based on the study done by Loukas et al. 70 % of specimens belonged to type A pattern, 24 % of specimens belonged to type B pattern and 6 % of specimens belonged to type C pattern. In 28 % of specimens, premasseteric branch was present. In 12 % of specimens, buccal branch was present. The average length of submental artery was 7.44 cm. The mean distance of origin of submental artery from the origin of facial arterywas 3.36 cm and from the angle of mandible was 2.88cm. Infra labial artery was present in 58% of cadaveric specimens and 53.33 % of angiograms. The average length of Inferior labial artery was 2.48 cm and superior labial artery was 6.04 cm. Inferior labial arteryarose from facial artery below the level of oral commissure in 72 %.Superior labial artery arose from facial arteryabove the level of oral commissure in 94 %.

The knowledge of facial artery anatomy is essential for better planning of reconstructive procedures, raising viable flaps and devising new flaps. It also helps the radiologists in better interpretation of radiological images andsurgeons for avoiding complications during surgeries .

**Key words :** Facial artery, Common linuo facial trunk, Submental artery, Inferior labial artery, Infra labial artery, Superior labial artery.

# INTRODUCTION

The facial artery is the main artery that supplies the structures of the face. It is widely used in plastic surgery as the pedicle of some flaps. The facial artery is responsible for the high vascularity of face which helps the skin to heal rapidly and gives excellent results during reconstructive surgery.

The facial artery (external maxillary artery)[16] originates from the anterior aspect of external carotid artery in the carotid triangle. The level of origin corresponds to the greater cornu of hyoid bone, above the origin of lingual artery[49]. From the carotid triangle it passes upwards and enters the digastric triangle by passing deep to the digastric and stylohyoid muscle. In the digastric triangle it runs upwards, medial to the ramus of mandible, grooving the posterior surface of the submandibular gland. It descends along a groove on the lateral surface of the submandibular gland, between the gland and the medial pterygoid to reach the lower border of the mandible. In the neck it is covered by skin, platysma, deep fascia and it is crossed by the hypoglossal nerve.

From the neck the facial artery enters the face by winding round the lower border of mandible, at the anteroinferior border of the masseter muscle. It runs upwards towards the angle of mouth. Here it lies superficial to the buccinator and levator anguli oris and deep to the zygomaticus major and

risorius. From the angle of mouth it runs along the side of the nose towards the medial angle of eye. Here it lies within the levator labii superioris alaquae nasi.

The facial vein is superficial to the artery in the neck, in contact with the artery at the anteroinferior border of masseter and posterior to the artery in the face.

Throughout its course the artery is tortuous to accommodate the movements of the neck and face. The arterial pulsation is palpable at the lower border of mandible and at the angle of mouth. The anaesthesiologist standing at the head end of the operating table can palpate the artery as it winds around the inferior border of the mandible, when the pulse of the other arteries are inconvenient to be palpated[2].

Facial artery gives a number of named and unnamed branches in the neck and the face. These branches anastomose with each other and with branches of other arteries of the face.

**Branches in the neck.**

The named branches in the neck are the ascending palatine, tonsillar, submental and glandular branches.

**Ascending palatine artery**

It arises from the facial artery near its origin. It ascends between the superior constrictor and medial pterygoid muscle and divides into two branches. One branch winds over the superior constrictor to anatomose with the opposite side and with the greater palatine branch of maxillary artery.It ends by supplying the soft palate. The other branch pierces the superior constrictor, anastomoses with tonsillar and ascending pharyngeal artery. It ends by supplying the tonsil and pharyngo tympanic tube .

**Tonsillar artery**

Tonsillar artery is the main blood supply of the palatine tonsil. It usually arises from the facial artery. But sometimes it may arise from the ascending palatine artery [49]. It passes between the medial pterygoid and styloglossus and pierces the superior constrictor muscle. It enters the tonsil through its inferior pole.

**Submental Artery**

It is the largest branch of cervical part of facial artery, given off when the artery separates from the submandibular gland[49]. It ascends upwards running over the mylohyoid muscle, passes over the mandible and terminates by dividing into superficial and deep branches. It anastomoses with the branches of sublingual and inferior alveolar artery and supplies the chin and the lower lip.

**Glandular branches**

These are three or four in number which supply the submandibular gland, lymph nodes and the overlying skin.

**Branches in the face**

The major named branches of facial artery given off in the face are the inferior labial, superior labial and lateral nasal. It also gives off an inconstant branch, the premasseteric artery which runs along the anterior border of the masseter muscle. The terminal part of the artery distal to the lateral nasal artery is called as angular artery [49].

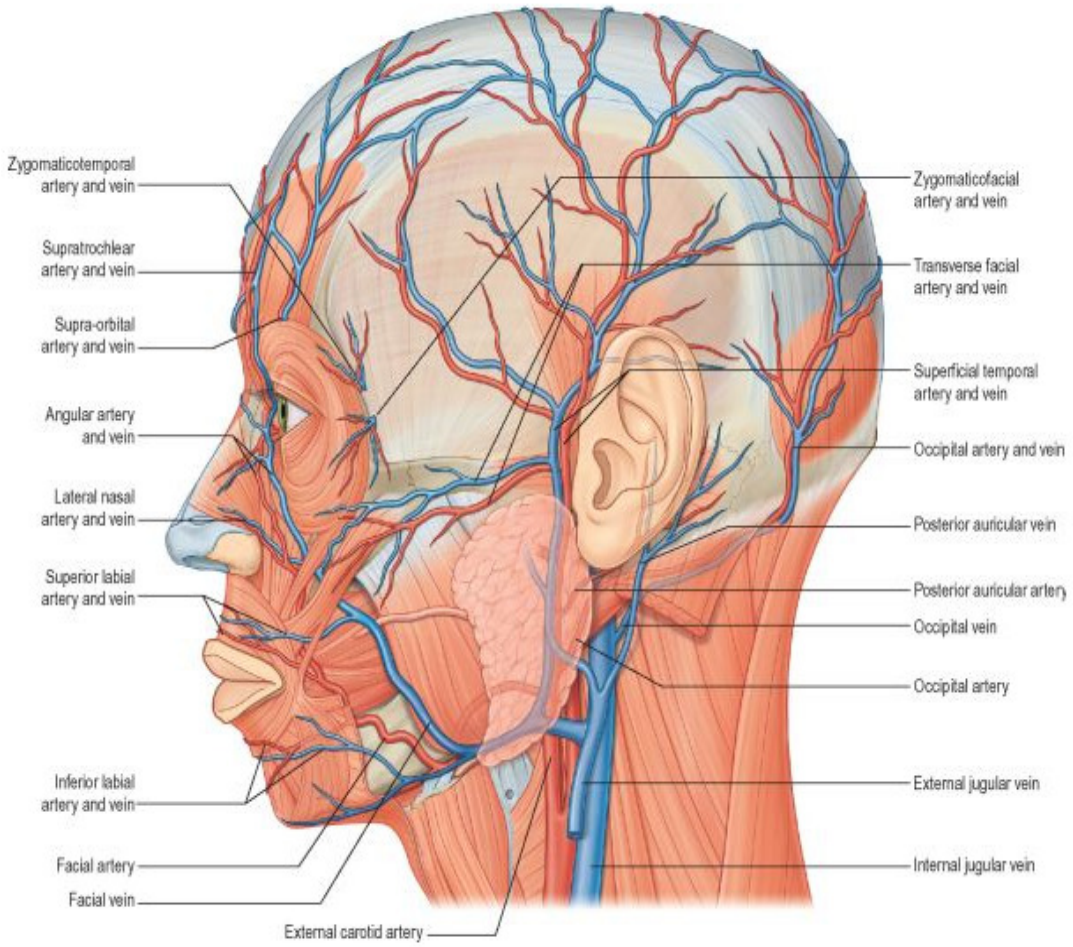
**Inferior Labial Artery**

It originates from the facial artery near the angle of mouth, runs upwards deep to the depressor anguli oris. It pierces the orbicularis oris, runs between the muscle and mucous membrane, along the lower margin of the lip. It ends by anatomosing with the opposite side artery and a branch from inferior alveolar artery.

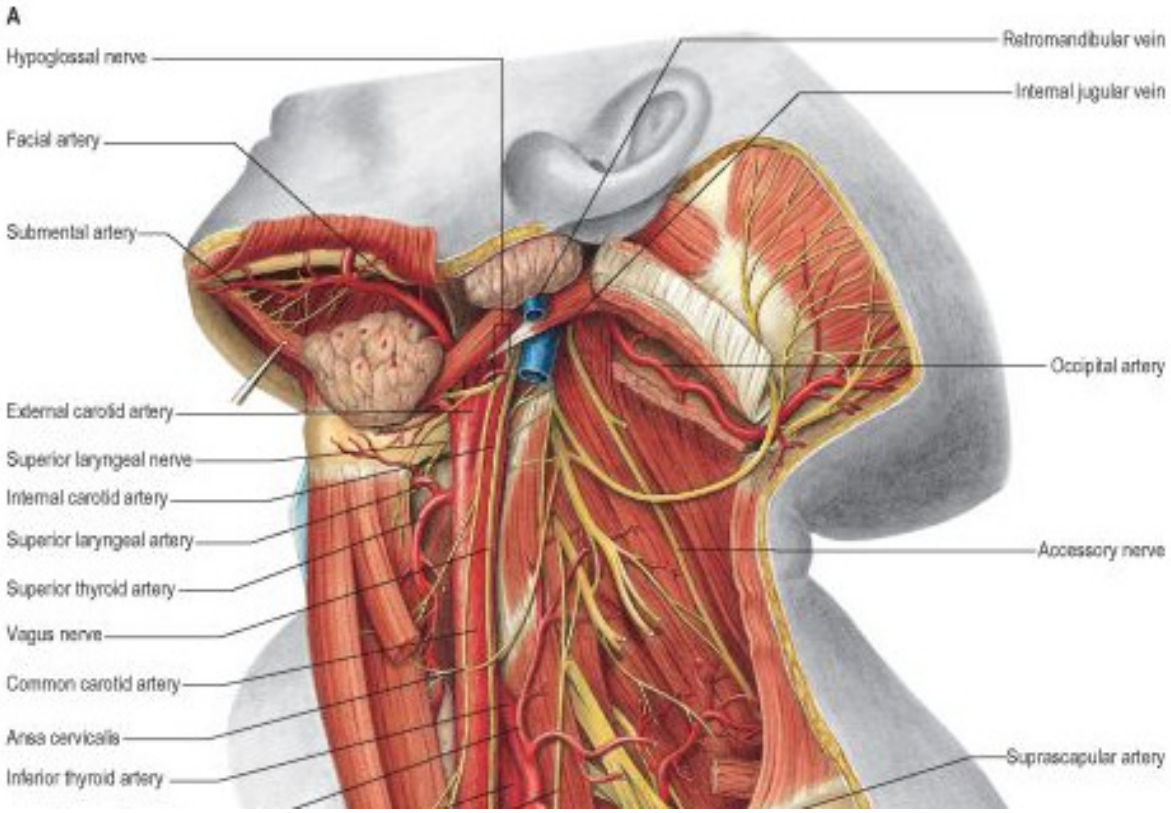
**Superior Labial Artery**

It is the main supply of the upper lip. It has a similar course like the inferior labial artery. But it is longer and more tortuous [49]. It runs between the orbicularis oris and mucous membrane along the upper margin of the lip. It gives off a septal and alar branch to supply the nasal septum.

# BRANCHES OF FACIAL ARTERY IN THE FACE



# ORIGIN AND COURSE OF FACIAL ARTERY IN THE NECK



# *Aim of the study*

# AIM OF THE STUDY

Reconstruction of facial defect is a common surgical procedure nowadays due to the increased frequency of malignancies, congenital abnormalities and trauma in this region. The aim of such procedure is the functional and aesthetic restoration to the face.

The main arterial supply of the facial skin envelope is the facial artery which serves as a main pedicle for a number of facial flaps. The knowledge of anatomy of facial artery is essential in raising viable facial flaps and devising new flaps.

Reconstruction of lip defects using the Abbe flap and other flaps requires manipulation of superior labial artery, one of the major branch of facial artery. The use of recently developed facial artery musculo mucosal flap (FAMM) is limited besides its various advantages due to the variations in the course of facial artery. Thus the assessment of facial vasculature is important in selecting the donor and recipient facial flaps.

The facial artery is selected as a target for super selective intra arterial chemotherapy during the treatment of certain cancers of the head.

Therapeutic radiological interventions like embolization of tumour feeding vessel in case of tumours including angiomas and arteriovenous

malformations in face need a thorough knowledge of the vascular pattern of face.

The aim of this study is to equip the surgeons, oncologists and academicians to have an understanding of the vasculature of face which helps in avoiding complications during surgeries. The knowledge of facial vasculature helps the plastic surgeons to have a confident approach in this area, thereby increasing the success rate of reconstructive surgeries .

The present study aims at studying the origin, location, branching pattern and mode of termination of facial artery in face and studying its submental and perioral branches in detail.

The following parameters are studied

**1.Facial artery (Main trunk)**

- Origin of facial artery

  Mode of origin

  i. Separate trunk from external carotid artery.

  ii. Common linguo facial trunk.

  Level of origin

  In relation to the carotid artery bifurcation

- Distance of facial artery crossing the mandibular margin from the angle of mandible.
- Branching pattern of facial artery in the face.
- Symmetry in the branching pattern of facial artery.
- Mode of termination of facial artery.

**2. Submental artery**

- Length of submental artery.
- Distance of origin of submental artery from the origin of facial artery.
- Distance of origin of submental artery from the angle of mandible

### 3. Infra Labial Artery/ Sublabial artery

1. Incidence of infra labial artery
2. Length of infra labial artery
3. Distance of origin of infra labial artery from the oral commissure.

### 4. Inferior Labial Artery

4. Origin of inferior labial artery in relation to the oral commissure.
5. Distance of origin of inferior labial artery from the oral commissure.
6. Length of inferior labial artery

### 5. Superior Labial Artery

- Origin of superior labial artery in relation to the oral commissure.
- Distance of origin of superior labial artery from the oral commissure.
- Length of superior labial artery.

# *Review of literature*

# REVIEW OF LITERATURE

## FACIAL ARTERY (MAIN TRUNK)

## ORIGIN OF FACIAL ARTERY

## MODE OF ORIGIN

**G.J.Romanes [13] [1972]** in Cunningham's textbook of anatomy, has quoted that FA arises from the anterior aspect of the ECA as a separate branch. He also stated that the FA can arise from the ECA as a single stem with lingual artery as 'common linguo facial trunk'

**Midy et al [31] [1986]** studied 40 FA and their collaterals. They observed that FA originated separately from the anterior aspect of external carotid artery in 37 cases (92.5 %) and originated from a common trunk with the lingual artery in 3 cases (7.5 %).

**Susan Standring [49] [2008]** in Gray's textbook of anatomy, has mentioned that the FA arises from the anterior aspect of external carotid artery as a separate trunk. While describing the branches of ECA, he stated that the lingual artery often arises with the FA.

**Ozgur et al [39] [2008]** evaluated 40 specimens for the branching pattern of ECA. They noted that all the front branches of ECA arose separately from the ECA trunk in 92.5 %, CLF trunk was observed in 7.5% and thyrolingual trunk was noted in 2.5 %.

**Fazan et al [11] [2009]** reported separate origin of FA in 78 % cases and origin from a common linguo facial trunk in 22 % cases. 4.8 % of cases had bilateral linguo facial trunk. The average length of linguo facial trunk was 0.94+/-0.17 cm on the right side and 0.76 +/- 0.13 cm on the left side.

**Lohn et al [24] [2011]** explored the course of FA by dissecting 201 FA. They reported separate origin of FA from ECA in 86% of specimens and common linguo facial trunk in 14% of specimens.

**Troupis et al [50] [2011]** observed a CLF trunk out of 15 cadavers. It was present unilaterally on the right side of a cadaver. The FA and LA on the left side originated separately from the ECA. The CLF trunk measured 0.73 cm before it bifurcated into facial and lingual arteries.

**Sirasanagandla et al [46] [2012]** found a variation during the routine dissection in a male cadaver of Indian origin. The FA on the right side originated from the common linguo facial trunk. The length of the linguo facial trunk was 0.4 cm.

**Mata et al [30] [2012]** analyzed the branching pattern of ECA**.** They reported that 77.8 % of cases showed separate origin of the front branches of ECA and 19.9 % of cases had a common linguo facial trunk. 2.8 % cases had thyrolingual trunk. They also found that among the combined arterial trunks, linguo facial trunk occurred more frequently than other trunks.

**S.Dnyanesh et al [48] [2013]** during their routine dissection for UG classes observed a case of unilateral linguo facial trunk on the right side of a male cadaver. The CLF trunk coursed upwards for 1.2 cm and then divided into LA and FA.

## LEVEL OF ORIGIN

**George A Piersol [15] [1930**] in his textbook 'Human Anatomy', has stated that the FA usually arises above the LA .But he also stated that the FA may arise from the ECA above the level of the angle of jaw.

**Midy et al [31] [1986]** measured the origin of FA in relation to various landmarks. The measured origin of FA from the CB was 1-3.5 cm. The distance of origin of FA from the LA was 0.5-1 cm and from the occipital artery was 0.2-0.6 cm.

**Bergman et al [43] [1988]** stated that FA can arise above its usual level, then descends beneath the angle of the jaw to assume its ordinary course. The arch thus formed, above the submandibular gland may extend for some distance beneath the ramus of the jaw, lying between the medial pterygoid and styloglossus muscles

**Nayak [36] [2006]** during his routine dissection found an abnormal origin of FA on the left side of a male cadaver. The FA originated in the substance of parotid gland behind the ramus of mandible. It then ran downwards, parallel to the base of mandible.

**Ozgur et al [39] [2008]** during their study for the branching pattern of ECA reported that the average distance of origin of FA from lingual artery was 1.82 cm.

**Susan Standring [49] [2008]** has stated that the FA arises from the ECA in the carotid triangle, above the origin of lingual artery just above the greater cornu of hyoid bone. He has stated that at the origin of FA, it is often crossed by the hypoglossal nerve.

**Jiang et al [20] [2008]** studied FA of 45 patients using spiral CT angiography. The left FA arose from the ECA in 44 cases. The average distance of origin of left facial artery from the CB was 0.45-4.79 cm (mean

1.87-/+0.89 cm). One FA on the right side of one case (2.2%) arose from the common carotid artery. The right FA arose from the ECA in all the 45 cases (100%) with distances from the carotid artery bifurcation of 0.68-3.97 cm. (mean 1.92 -/+ 0.82 cm).

**Mohandas Rao et al [32] [2009]** noted a rare variation in the origin of FA on the left side of a male cadaver during their routine dissection. Here the FA originated high in the digastric triangle, 0.5 cm above the CB, 2 cm above the level of posterior belly of digastric.

**Mamatha et al [29] [2010]** noted a variation in the branching pattern of ECA. The FA originated 2.9 cm above the CB, 1.5 cm above the posterior belly of digastric, in the digastric triangle**.** The FA did not give glandular branch and there was no looping around the gland.

**Troupis et al [50] [2011**] reported an unilateral CLF trunk on the right side of a cadaver. The origin of the CLF trunk was 0.79 cm from the CB and 0.33 cm from superior thyroid artery.

**Laxman et al [23] [2014]** reported a bilateral variation in the branching pattern of ECA. On both sides STA originated from CCA. FA on the left side originated high in the digastric triangle, above the posterior belly of digastric muscle (4.2 cm from the CB) .The glandular branches to the submandibular gland were originating from the ECA instead of the FA.

**DISTANCE OF FACIAL ARTERY CROSSING THE MANDIBULAR MARGIN FROM THE ANGLE OF MANDIBLE**.

**Koh et al [22] [2003]** studied 47 head and neck specimens and analyzed the measurements of facial vessels related to mandibular landmarks. The average distance of FA crossing the MM from MA was 2.72 +/- 0.56 cm in males and 2.68 +/ 0.48 cm in females. They found that there was no significant difference based on laterality or gender.

**Magden et al [28] [2004]** dissected submental regions in 13 formalin fixed cadavers and found that the FA passed deep to the anterior belly of digastric in 81 % specimens and they crossed the mandibular margin at a mean distance of 2.66 cm from the angle of mandible.

**Cicekcibasi et al [7] [2012]** evaluated FA in 30 specimens with Multidetector Computed Tomography Angiography (MDCTA) in living individuals and reported that the average distance from the mandibular angle to the point where FA first appears at the lower margin of mandible was 3.53 +/-0.66 cm and 3.31 +/- 0.73 cm in males on the right and left side respectively. It was 2.91 +/- 0.52 cm and 3.35 +/- 0.48 cm in females on the right and left side respectively.

## BRANCHING PATTERN OF FACIAL ARTERY IN THE FACE

There are different classifications for FA branching pattern in the literature due to the wide variation in the branching pattern. Some classifications are based on mode of termination. Some are based on the branches of FA in the face.

**Nakajima et al [34] [2002]** reported three patterns of FA distribution in the face after their study on 25 FA. In 22 cases (88%) the FA bifurcated as LNA and SLA at the angle of mouth. In 2 cases (8%) the FA terminated as AA after branching into SLA and LNA. In 1 case (4%) the FA continued as AA after branching into SLA. Here the LNA arose from the SLA.

Branching pattern described by Nakajima et al

**Loukas et al [25] [2006]** examined 284 hemifaces and based on their observation, had classified the branching pattern into five types A – E.

In Type A, the FA bifurcated into SLA and LNA, where the LNA ended as AA after giving off SAA and IAA.( found in 135 cases,47.5%).

In Type B, the FA bifurcated into SLA and LNA, but here the LNA ended as SAA . AA was absent.( noted in 110 cases,38.7 %)

In Type C, the FA terminated as SLA (observed in 24 cases, 8.4%)

In Type D, the FA terminated as SAA. Here AA arose directly from the FA (found in 11 cases, 3.8 %)

In Type E, the FA terminated as a rudimentary twig without giving any branches.(found in 4 cases, 1.4 %)

They also classified the types A- C into various subtypes.

In A-1, FA after giving off SLA, ascended as LNA and continued as AA.

In A-2, FA trifurcated into SLA,LNA and AA

In A -3,FA ended as AA. Here LNA arose from SLA.

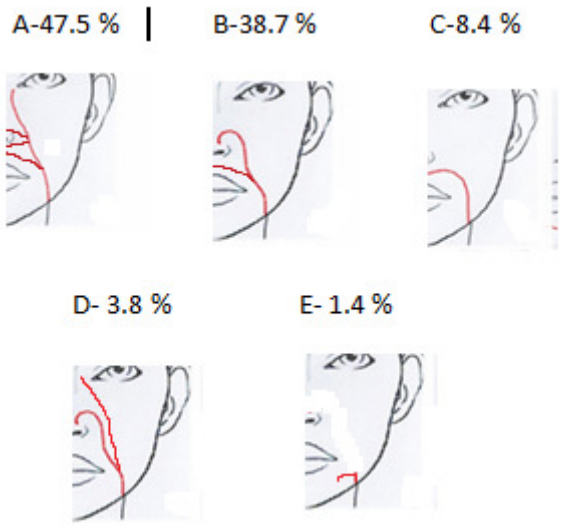
In A-4, IAA from LNA provided the septal branches.

In A-5, similar to type A-2, septal branch anastomose IAA.

In A -6,similar to type A-3.AA supplied the nose.

In A-7,SLA gave rise to septal branch which replaced the LNA.

Branching pattern described by Loukas et al




**Susan Standring [49] [2008]** described the normal branching pattern of FA in face. The FA gives off the superior labial and inferior labial arteries near the angle of mouth. Then it gives off the lateral nasal artery by the side off the nose. It also gives off an inconstant branch, the premasseteric artery in the face. After giving off its last branch it continues along the side of the nose towards the medial angle of eye as angular artery.

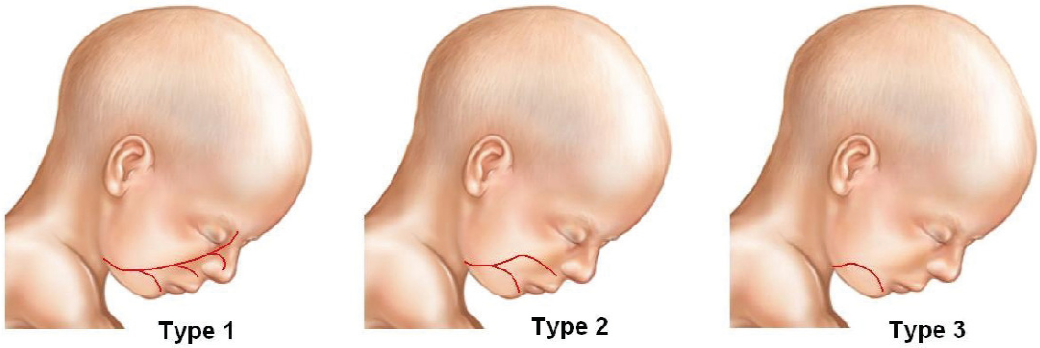
**S.B.Bayram et al [47] [2010]** had classified the FA branching pattern in foetuses.

In type I, the FA terminated as AA and was noted in 76 %.

In type II, the FA terminated as SLA ,which was observed in 12 %.

In type III, the FA terminated as ILA, found in 12 %.

Branching pattern described by Bayram et al




**George Dickson et al [14] [2013]** studied 40 FA and classified the branching pattern of FA into six major types based on the termination of the artery.

Type – I - FA terminated as SLA

Type –II - FA terminated as ILA

Type –III - FA terminated as LNA

Type –IV - FA terminated as SAA

Type –V - FA terminated as IAA

Type –VI - FA terminating as AA.

He also mentioned that the termination as superior labial and angular arteries (type I and type VI ) were the most common , 55 % of the total specimens studied.

Branching pattern described by George Dickson et al


**L.S.Quadros et al [26] [2013]** grouped the variations in the branching pattern into three types based on classification done by Bayram et al. They examined 38 male and 12 female cadavers. All the specimens on the right side of male cadavers showed type I pattern where the FA terminated as AA. On the left side 78 % had type I and 22 % had type II pattern (here the FA terminated as SLA).Among the 12 female cadavers, on the right side type I was noted in 80 % and type II in 20%.On the left side, type I was observed in 80%, type II in 18 % and type III in 2 % (here FA terminated as ILA).

## Presence of unusual branches of facial artery in the face

**George A Piersol [15] [1930]** has mentioned about masseteric branches arising from the posterior surface of the artery, directed upwards to supply the muscle and anastomosing with the branches of internal maxillary artery and transverse facial artery.

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**Zhao et al [53] [2002]** detected the presence of branches of FA in the buccinator region by doppler method in 92.4 % of cases.

**Susan Standring [49] [2008]** has stated that the premasseteric branch is a small and inconsistent named branch of FA given off in the face.

**Orhan Magden et al [38] [2009]** analyzed premasseteric branch of FA by microdissection method in 27 cases. They found that the premasseteric branch originated separately from the FA in all cases. All the branches ran at the anterior border of masseter muscle. It gave a superficial and a deep branch. In 3 % cases the diameter of premasseteric branch was larger than the FA.

**Ariji et al [4] [2010]** in their study on the blood supply of masseter muscle, found that in 98.7 % of cases branches from transverse facial artery supplied the muscle. In 84.2 % of cases branches from ECA supplied the muscle and in 21.1 % of cases masseteric branches of FA were found. Facial artery that fed the muscle from the inferior part represented 2 patterns

according to anatomic variant: the masseteric branch (22.4%) and the main trunk itself (77.6%)

**Kumar et al [35] [2011]** observed an unusual posterior branch of FA (premasseteric branch) from the right FA of a male cadaver. It ran upwards behind the FA and terminated by anastomosing with the infraorbital artery. The ILA on that side was absent. On the left side ILA was dominant. The left ILA was large and it supplied the entire lower lip.

**Won et al [52] [2012]** evaluated the blood supply of masseter muscle. The masseter muscle was supplied by seven branches from the ECA. Among these branches the branch from the transverse facial artery is the most common supply to the muscle.

**Lydia S.Quadros et al [26] [2013]** studied the course and variation in the branching pattern of FA in 50 hemifaces. They noted prominent and large premasseteric branch in 4 hemifaces which had type I pattern (FA terminating as AA) and 1 premasseteric branch belonged to type II FA (terminating as SLA).

**Saleem Itoo et al [33] [2013]** observed a rare variation in the branching of left FA in an Indian male cadaver. It originated normally from the ECA .An anomalous branch arose from FA midway between the origin of ILA and anteroinferior border of masseter muscle. This anastomosed with the branches

of infraorbital and transverse facial arteries. The other major branches were relatively smaller on the left side. The PM branch was absent on both sides of the face. The FA on the right side had normal branches.

## SYMMETRY IN THE BRANCHING PATTERN OF FACIAL ARTERY.

**Niranjan et al [37] [1988]** reported the anatomical variation of FA in 25 adult cadavers. Out of the 25 cadavers dissected, 17 showed bilateral symmetrical branching pattern (68%).

**Koh et al [22] [2003]** investigated the topography and course of FA in 47 cadavers. They observed that FA in 54.5 % of cadavers ended symmetrically.

**Pinar et al [40] [2005]** dissected 25 adult cadaveric heads for studying the blood supply of the perioral region. They found symmetrical branching pattern on both sides in 17 heads (68 % cases).

## MODE OF TERMINATION OF FACIAL ARTERY

**George A Piersol [15] [1930]** has stated that the terminal portion of the FA beyond the nasolabial fold is called as AA. It gives branches to the adjacent structures, anastomoses with nasal branch of the ophthalmic artery and with the infraorbital branch of internal maxillary artery.

**J.C.B.Grant [18] [1958]** in his book 'A Method of Anatomy' has stated that the FA terminates at the angle of mouth by dividing into angular artery and lateral nasal artery.

**Henry Hollinshed [16] [1961]** has stated that the FA runs along the side of the nose towards the medial angle of eye as AA. He also said that the AA ends by dividing into small branches or ends by anastomosing with the dorsalis nasi branch of ophthalmic artery and runs downwards to supply the nose.

**Midy et al [31] [1986]** stated that the termination of FA is highly variable. They presented 4 types of termination of FA , labial, angular, nasal and abortive.

**Niranjan [37] [1988]** reported that out of 59 FA dissected, 34 FA terminated as AA(68%), 13 FA terminated as LNA (26 %), 2 FA terminated as SLA (4%) and in one case FA terminated at the alar base (2 %). In 5 cases 10% the FA had a longer course.

**Bergman et al [43] [1988]** has stated that the FA is frequently rudimentary. It may terminate as a SMA, not reaching the face, or as SLA , LNA without forming AA (43% of cases studied). When absent, it may be replaced by the transverse facial, the maxillary artery or the nasal branch of the ophthalmic artery. FA when larger than usual may replace the frontal branches of the ophthalmic or the nasal artery. The submental branch of the FA may arise from the LA.

**Crouzet et al [5] [1998]** dissected 40 FA and found that in 9 specimens FA was dominant on one side compared to the other side. Such vascular dominance was not observed in 10 specimens. In one specimen the blood supply of the lower lip was dependent on the left FA and the upper lip on the right side FA. Out of 40 FA, 36 FA terminated as alar artery, 3 FA ended as AA and one FA ended in the upper lip .

**Koh et al [22] [2003]** in their study of 47 cadavers observed that in 44 % cases FA terminated as LNA and in 36.3 % FA terminated as AA. They also showed that the variation in the branching pattern demonstrated individual variation and there was no racial difference.

**Pinar et al [40] [2005]** described the mode of termination of FA in 50 specimen. 30 FA (60 %) ended as a nasal vessel, 11 FA(22%) ended as an angular vessel (22%), 6 FA (12 %) ended as an alar vessel, in 2 cases(4%) FA

ended as a superior labial vessel. There was a single FA (2%) where it was hypoplastic.

**Loukas et al [25] [2006]** described 3 terminal branches. 51.4 % of specimens terminating as AA, 38.73 % terminating as LNA, 8.4 % terminating as SLA, 1.4 % terminating as rudimentary artery.

**Susan Standring [49] [2008]** has stated that the common mode of termination of FA is the AA, which is the continuation of FA after giving off LNA. He also said that sometimes FA do not extend beyond the angle of mouth. In such cases the part of face above the angle of mouth is supplied by a large transverse facial artery or the opposite side FA.

**Jiang et al [20] [2008]** evaluated the FA and its branches in 45 patients using CT angiography. They reported that the left FA terminated below the angle of the mouth in 12 cases (26.67%), ended between the angle of the mouth and the nasal wing in 7 cases (15.56%), and ended above the nasal wing in 26 cases (57.77%). The right FA terminated below the angle of the mouth in 7 cases (15.56%), ended between the angle of the mouth and the nasal wing in 12 cases (26.67%), and ended above the nasal wing in 26 cases (57.77%).

**S.B.Bayram et al [47] [2010]** examined FA in foetuses and reported that 76 % FA terminated as AA. 12 % FA terminated as SLA, and 12 % FA terminated as ILA.

**L.S.Quadros et al [26] [2013]** studied the gender variation of FA termination and observed that FA terminated as AA or ILA in males and terminated as AA or ILA or SLA in females.

**Furukuwa et al [12] [2013]** evaluated 187 FA in 94 patients using the CT angiography for its branching pattern. They presented 4 types in their study. In type 1, FA had a short course, terminating proximal to the SLA; In type 2, it had an intermediate course terminating distal to the SLA near the nasolabial fold; In type 3, it had a classic course, extending to the lateral nasal ala and terminated as AA; and in type 4, FA had duplex with dominant lateral angular branch. 64 FA (34 %) belonged to type 1. 74 cases (40%) were classified as type 2. 45 FA (24%) were type 3. Type 4 was noted only in 2 %.

**Vrushali et al [51] [2014]** reported a bilateral variation in the course of FA. The FA on both sides terminated as ILA. The main supply of the face was by the transverse facial artery .This artery was enlarged and gave origin to the SLA and LNA. A PM branch was given off from the FA on the right side.

## HYPOPLASTIC/ RUDIMENTARY FACIAL ARTERY

**Henry Hollinshed[16] [1961]** has quoted about the occurrence of hypoplastic artery which extended only upto the angle of mouth

**Pinar Y.A et al [40] [2005]** observed hypoplastic FA in 1 case (2%)

**Tubbs et al [41] [2005]** reported an unilateral agenesis of FA on the left side of a male cadaver during routine dissection. The transverse facial artery was enlarged on that side which measured 1.05 cm in length and 5 mm in diameter. It gave rise to SLA and LNA on that side. No AA was present on the left side.

**Loukas et al [25] [2006]** noticed rudimentary FA in 4 specimens (1.4%) with no SLA, LNA and AA. They classified the rudimentary FA as type-E.

**Lohn et al [24] [2011]** reported 5 rudimentary FA in his study of 201 FA. In all these cases transverse facial artery was dominant.

**Hiromitsu Ezure et al [17] [2011]** reported a case of complete absence of FA on the left side of a male cadaver. The absence of FA was compensated by the larger transverse FA on that side.

## SUBMENTAL ARTERY

### LENGTH OF SUBMENTAL ARTERY

### DISTANCE OF ORIGIN OF SUBMENTAL ARTERY FROM ORIGIN OF FACIAL ARTERY

### DISTANCE OF ORIGIN OF SUBMENTAL ARTERY FROM ANGLE OF MANDIBLE.

**Magden et al [28] [2004]** dissected submental regions in 13 cadavers and presented the parameters related to the SMA as follows: the mean length of SMA was 5.89 cm. The mean distance between the origin of SMA and the origin of FA was 2.75 cm. The mean distance of SMA from the MA was 2.38 cm.

**Susan Standring [49] [2008]** has stated that the SMA is the largest cervical branch of FA as it separates from the submandibular gland. It anastomoses with the branches of LA, ILA and mental arteries to supply the chin and the lower lip.

**Chummy S. Sinnathamby [6] [2011]** in Last's anatomy, has mentioned that the FA gives a sizable branch, the submental artery just before crossing the inferior border of masseter, 2.5 cm in front of the angle of mandib

## INFRA LABIAL ARTERY

### INCIDENCE OF INFRA LABIAL /SUB LABIAL ARTERY

When two inferior labial arteries are present, the proximal ILA is known as infralabial or sublabial artery.

**George A Piersol [15] [1930]** has mentioned about two ILA, where one runs parallel to the ramus of mandible, anastomosing with the mental and submental arteries.The other branch runs between the mucosa and orbicuaris oris of lower lip and anastomoses with the opposite side.

**J.Parsons Schaffer [19] [1952]** in Morri's Anatomy has said that the ILA has an additional branch in the face. He names the second ILA as sublabial artery that runs from the FA to region just below the lower lip.

**F.Wood Jones [10] [1953]** in Buchanan's Manual of Anatomy, has mentioned the ILA can be two in number. He referred the first branch as inferior coronary artery and the second branch as mental branch.

**Ernest Gardner et al [9] [1960]** in their textbook 'Anatomy-A regional study of human structure' have mentioned that among the branches of FA , ILA usually occurs in two number.

**Henry Hollinshed [16] [1961]** has mentioned that FA gives off ILA before it reaches the lower lip. It runs medially in the lower lip and anastomoses with

the opposite side artery. He said that this artery may be double. The lower artery supplies the medial, upper and lateral part of the lip.

**Russell T.Woodburne [44] [1961]** has said that the ILA occurs as two arteries and he referred the second ILA as the infra labial artery which runs in the sulcus between the lower lip and chin.

**Edizer et al [8] [2003]** investigated the arterial antomy of the lower lip in 14 adult cadavers. They reported that sublabial artery was present in 10 cases (71%) **.**

**Susan Standring [49] [2008]** has mentioned ILA as a single artery arising from the FA in the face near the angle of mouth.

**LENGTH OF INFRALABIAL ARTERY**

**DISTANCE OF ORIGIN OF INFRALABIAL ARTERY ORIGIN FROM THE ANGLE OF MANDIBLE**

**Edizer et al [8] [2003]** presented the study on the blood supply of lower lip where the average length of sublabial artery (infra labial artery) was 2.34 cm and the mean distance between the origin of infra labial artery from the angle of mouth was 2.76 cm.

# INFERIOR LABIAL ARTERY

## LENGTH OF INFERIOR LABIAL ARTERY

## ORIGIN OF INFERIOR LABIAL ARTEERY IN RELATION TO THE ORAL COMMISURE

## DISTANCE OF ORIGIN OF INFERIOR LABIAL ARTERY FROM ORAL COMMISSURE

**Edizer et al [8] [2003]** studied the arterial anatomy of lower lip in 28 specimens and derived various parameters related to ILA. They reported that the ILA was the main artery of the lower lip in all the specimens and they were always the branch of FA. The mean length of ILA was 5.23 cm. The average distance between the origin of ILA from the OC was 2.39 cm.

**Pinar et al [40] [2005]** studied the ILA in relation to the angle of mouth in 50 specimens. In 4 specimens ILA was above the angle of mouth (8%). In 11 specimens ILA was below the angle of mouth (22%). In 30 specimens ILA was at the angle of mouth (60%). In 10 % specimens ILA was absent.

**Nayak [36] [2006]** during his routine dissection observed a rare variation in the origin and branching pattern of FA. After originating inside the parotid gland it coursed through the digastric triangle. It gave the ILA just below the

base of the mandible. It ascended to the face at the anteroinferior angle of masseter.

**Susan Standring [49] [2008]** has quoted that the ILA originated from the FA near the angle of mouth and runs upwards under the depressor angulioris.

**Aravena et al [3] [2008]** studied the labial arteries on human cadavers and reported that the lower artery showed a great variation with reference to it's origin. All the ILA originated from the FA separately. The level of origin was closer to the basilar edge than the OC. The average distance of ILA from OC was 3.05 cm.

**Al Hogail et al [1] [2008]** investigated the arterial supply of the lower lip. They reported that the blood supply of the lower lip was by the ILA, horizontal and vertical labio mental arteries. The ILA arose below the labial commissure in 42.9% and with SLA as a common stem in 28.6 %. The horizontal labio mental arteries were found in all specimens. The vertical labio mental arteries were found only in 21.4 % of specimens.

**Schulte et al [45] [2009]** studied the course of 15 ILA. The artery was single in all the cases. In the central portion of the lip the artery was within the orbicularis oris muscle in 13 % and between the mucosa and orbicularis oris in 87 % of cases. The course of ILA was variable, located at about 1.5 cm from the free margin of the lower lip.

## SUPERIOR LABIAL ARTERY

### LENGTH OF SUPERIOR LABIAL ARTERY

### ORIGIN OF SUPERIOR LABIAL ARTERY IN RELATION TO THE ORAL COMMISSURE

### DISTANCE OF ORIGIN OF SUPERIOR LABIAL ARTERY FROM THE ORAL COMMISURE

**G.J.Romanes [13] [1972]** has quoted that the labial branches are given off from the FA trunk 1-1.5 cm from the angle of mouth.

**Ran et al [42] [1998]** studied 8 cadavers to observe the blood supply of nasolabial fold. They found that SLA was present in all cases and the average length of SLA was 9 cm. The SLA on both sides anastomosed in the midline through arcuate arteries which were present in the submucous layer. They also showed that ligation of FA before the origin of SLA did not affect the blood supply to the nasolabial fold due to this anastomosis.

**Magden et al [27] [2004]** investigated the arterial distribution of upper lip in 14 cadaver heads and reported that the SLA was the main artery of the upper lip and always originated from the FA. But the level of origin of SLA and its branches varied. The mean length of SLA was 4.54 cm (2.9-8.5

cm).The average distance of SLA from the lower border of mandible was 4.64 cm. The mean distance between the origin of SLA from the OC was 1.21 cm.

**Pinar et al [40] [2005]** studied SLA in relation to the angle of mouth. In 34 out of 47 specimens (72.3%) the SLA was superior to the angle of mouth. In 13 specimens (27.7%) the SLA was at the angle of mouth. In 2 specimens the SLA was the continuation of FA. One SLA was hypoplastic.

**Susan Standring [49] [2008]** in Gray's Anatomy, has stated that the SLA has a similar course like ILA but is longer than the ILA.

**Aravena et al [3] [2008]** traced the labial arteries in 18 specimen. In all the samples SLA originated from the FA separately on the OC with an average distance of 1.17 cm.

**Al-hoqail et al [1] [2008]** studied the arterial supply of the lips in 14 cadavers. The main blood supply to the upper lip was by the SLA. The SLA arose above the labial commissure in 78.6 %. Septal and subalar branches also contributed to it. Septal branches were present in all specimens. Subalar branch was absent in a single specimen.

**Schulte et al [45] [2009]** dissected the mid and lower face regions of 24 adult heads and concluded that the SLA was single in all cases. At the OC, the artery was superior to the vermilion border (94 %). At the midline, the artery

was within the vermilion border (75%). It was within the orbicularis muscle in 19% cases and between the muscle and mucous membrane in 81 %. It was found within 1 cm of the free margin of the upper lip.

# *Embryology*

# EMBRYOLOGY

During the 4th week of embryonic development, pharyngeal arches develop and each arch receives its own blood supply from the aortic sac. These arteries, the aortic arches are embedded in the mesenchyme of the pharyngeal arch and terminate in the right and left dorsal aortae. Thus the embryonic aortic arches are paired bilateral series joining the ventral and dorsal aorta. With further development of the embryo the aortic arches lose their original symmetrical form and establish a definitive pattern.

The aortic arches develop in a craniocaudal sequence. When the third arch is established the first two arches are already dwindling. By the 27th day the first arch disappears completely. By the 29th day, second arch (hyoid artery) disappears. But the dorsal end of the artery persists as the stem of the stapedial artery, virtually supplying the entire facial region.

The external carotid artery first appears as a sprout which grows headward from the aortic sac close to the ventral end of the third aortic arch. The proximal portion of the third aortic arch vessel that is adjacent to the internal carotid grows forward and upward and has fused with stapedial artery. Only a small portion of the stem of the stapedial artery persists at this stage.

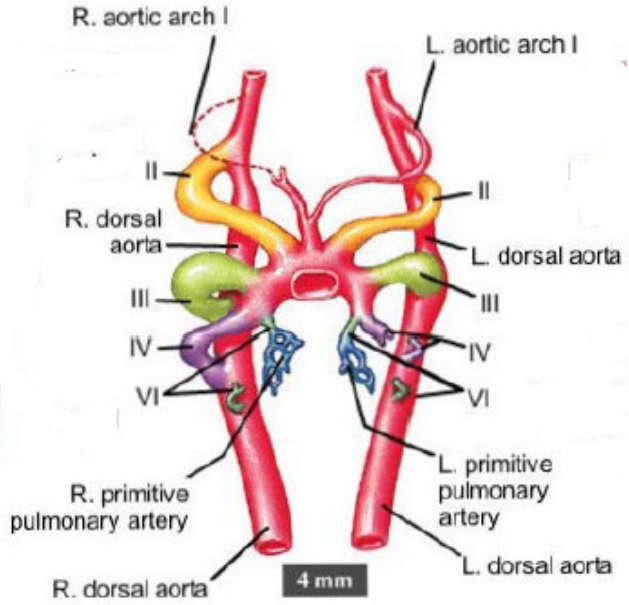
The source of blood supply to the territory of the trigeminal nerve varies at different stages of development. When the first and second aortic arch

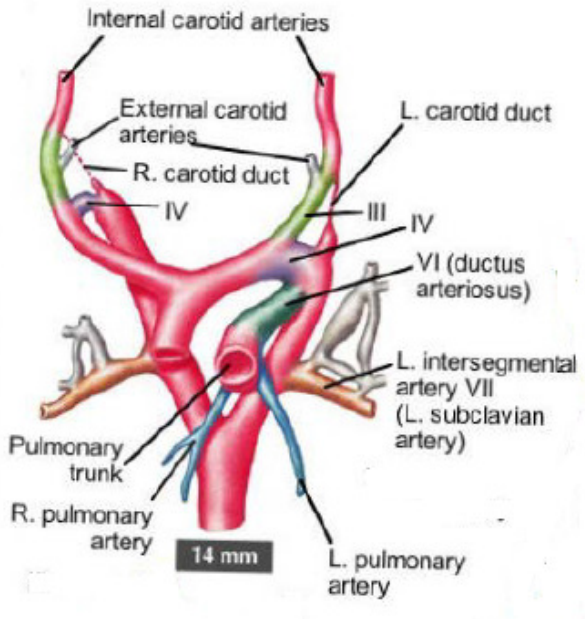
arteries begin to regress and by the time the third arch appears, the supply to the corresponding arch is derived from a transient ventral pharyngeal artery. This grows from aortic sac and terminates by dividing into mandibular and maxillary branches. A pair of mandibular arteries grow into the region occupied by the first pair of aortic arches. Later on, the stapedial artery develops and passes through the condensed mesenchymal site of the future ring of stapes and replaces second pair of arches in the hyoid brachial arches. It anastomoses with the terminal end of the ventral pharyngeal artery. The fully developed stapedial artery possess three branches namely the maxillary, mandibular and the supraorbital, which follow the division of trigeminal nerve. The mandibular and maxillary diverge from a common stem.

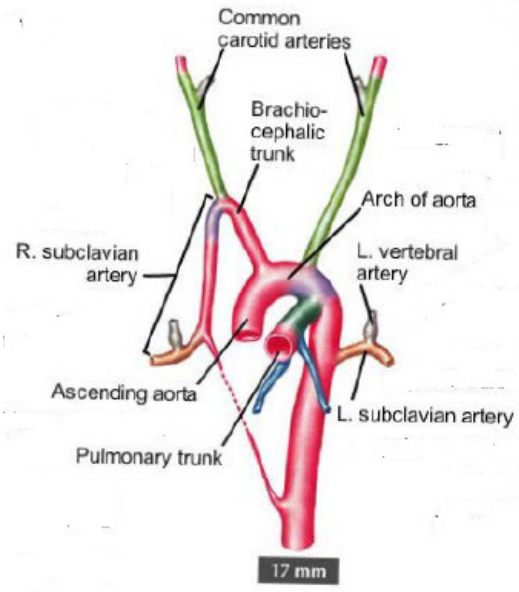
When the external carotid artery emerges from the base of the third arch, it incorporates the stem of the ventral pharyngeal artery. The external carotid artery grows headward along the ventral wall of the pharynx and divides into superficial temporal and maxillary branches. Its maxillary component joins with the common trunk of maxillary and mandibular branches of the stapedial artery. Thereafter the stapedial artery regresses and the maxillary and mandibular arteries are incorporated in the ECA.

The maxillary artery is continued as infraorbital artery and the mandibular artery forms the inferior alveolar artery. Thus the ECA and its branches form the definitive vascular system for most of the face.

# DEVELOPMENT OF EXTERNAL CAROTID ARTERY



# *Materials and Methods*

# MATERIALS AND METHODS

## STUDY MATERIAL

The study material consists of

1. 25 adult cadaveric heads (50 hemifaces)
2. 15 adult carotid artery angiograms

## METHOD OF STUDY

1. Conventional dissection method
2. Radiological study

## SPECIMEN COLLECTION

1. Adult human head and neck specimens were collected from embalmed cadavers allotted for routine academic dissections to the first M.B.,B.S, and first B.D.S students at the Institute of Anatomy, Madras Medical College, Chennai.

2. 15 adult carotid artery angiograms were collected irrespective of the patient particulars from the Barnard Institute of Radiology, Rajiv Gandhi Government General hospital, Chennai.

## CONVENTIONAL DISSECTION METHOD

The dissection was carried out as follows

The skin, platysma , and the superficial fascia over the carotid triangle on each side of the neck and face were carefully reflected laterally from a midline incision. The margins of the sternocleidomastoid and the superior belly of omohyoid were defined after reflecting the deep cervical fascia. The submandibular gland was mobilised, after defining the margins of the posterior belly of digastric and stylohyoid above. The carotid sheath in the carotid triangle was opened and the external carotid artery with its branches were identified. The third branch from the external carotid in the neck, the facial artery, was identified and it was traced distally deep to the mandible.

The level of origin and the mode of origin of FA was noted. The submental artery which arose from the FA, as the artery separated from the submandibular gland was identified. This branch was traced as it turned forwards on the mylohyoid muscle to the anterior belly of digastric and to the chin. The distance of origin of the SMA from the origin of FA was measured in each specimen and recorded. The distance of origin of SMA from the angle of mandible was measured in each specimen and recorded. The length of SMA was measured in each specimen and tabulated.

The SLA and ILA branches were traced up to their anastomoses in the midline. The length of these branches, relation of these branches to the angle of mouth (oral commissure), distance of origins of these branches from the OC were recorded. The facial trunk was traced on the face till its termination. The branching pattern and its mode of termination in the face were noted.

## RADIOLOGICAL METHOD

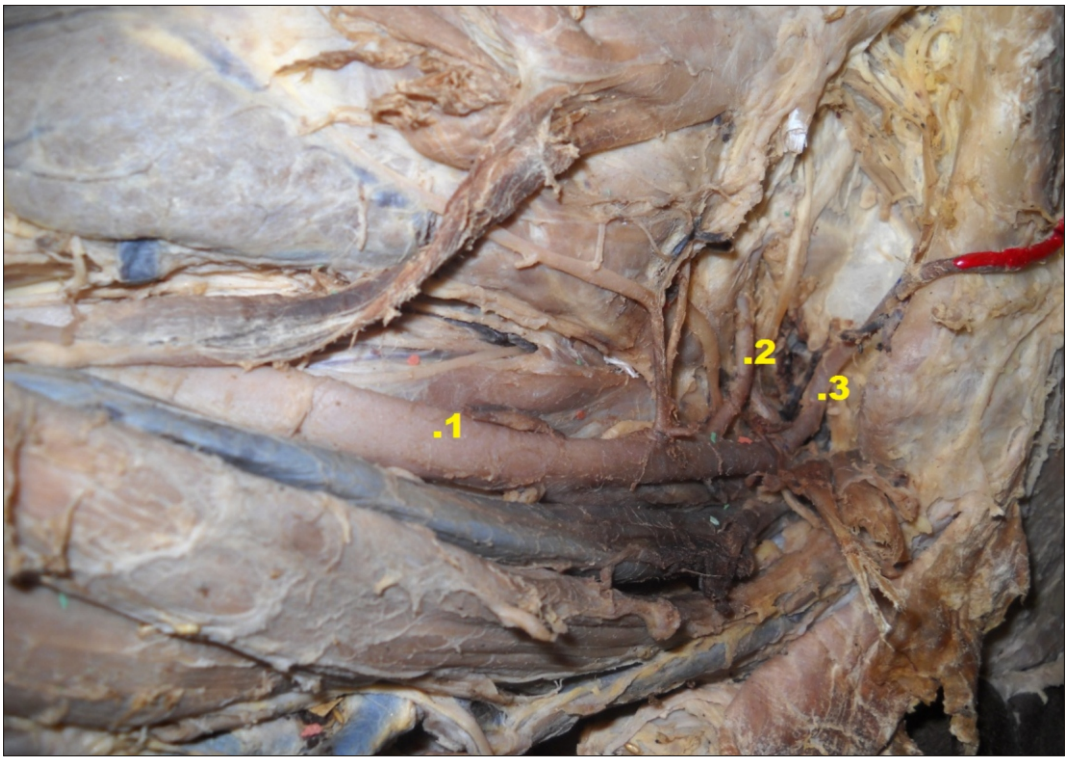
15 adult carotid angiograms were obtained from archives of Barnard Institute of Radiology and the FA was studied.

# *Observation*

**Fig 1 : origin of FA separately from ECA**

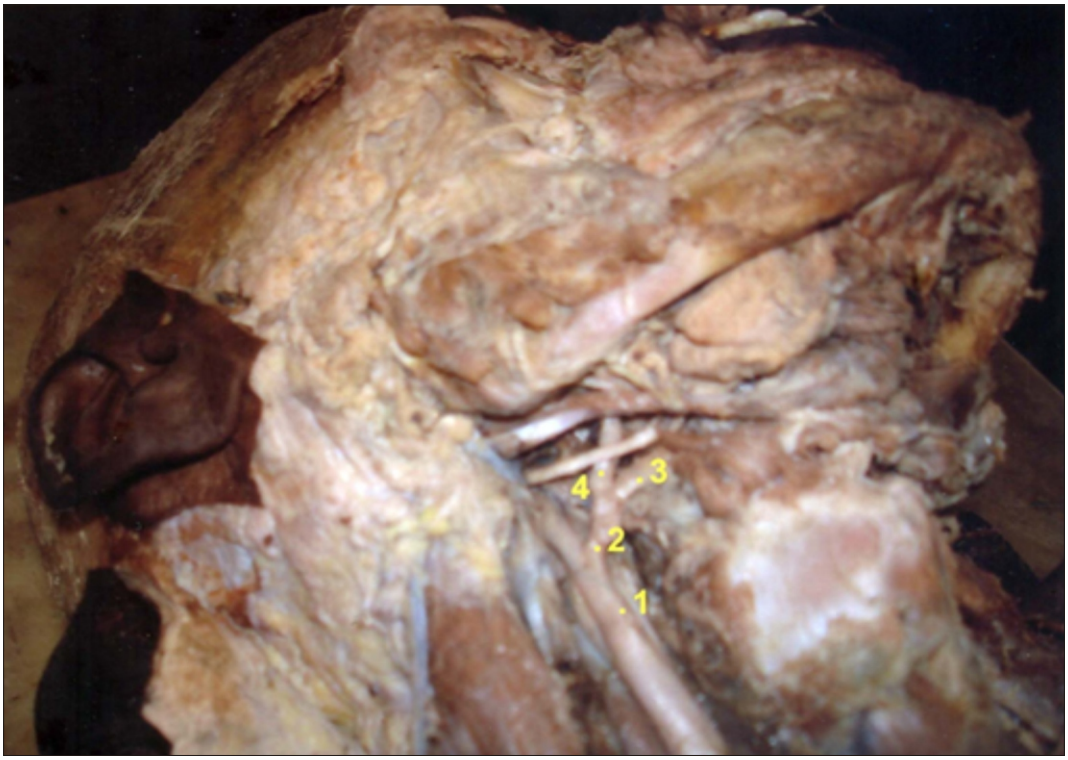

**1. ECA 2. STA 3. LA 4. FA 5. Hypoglossal nerve**

**Fig 2 : Origin of FA separately from ECA**
**[after removal of SMG and hypoglossal nerve]**



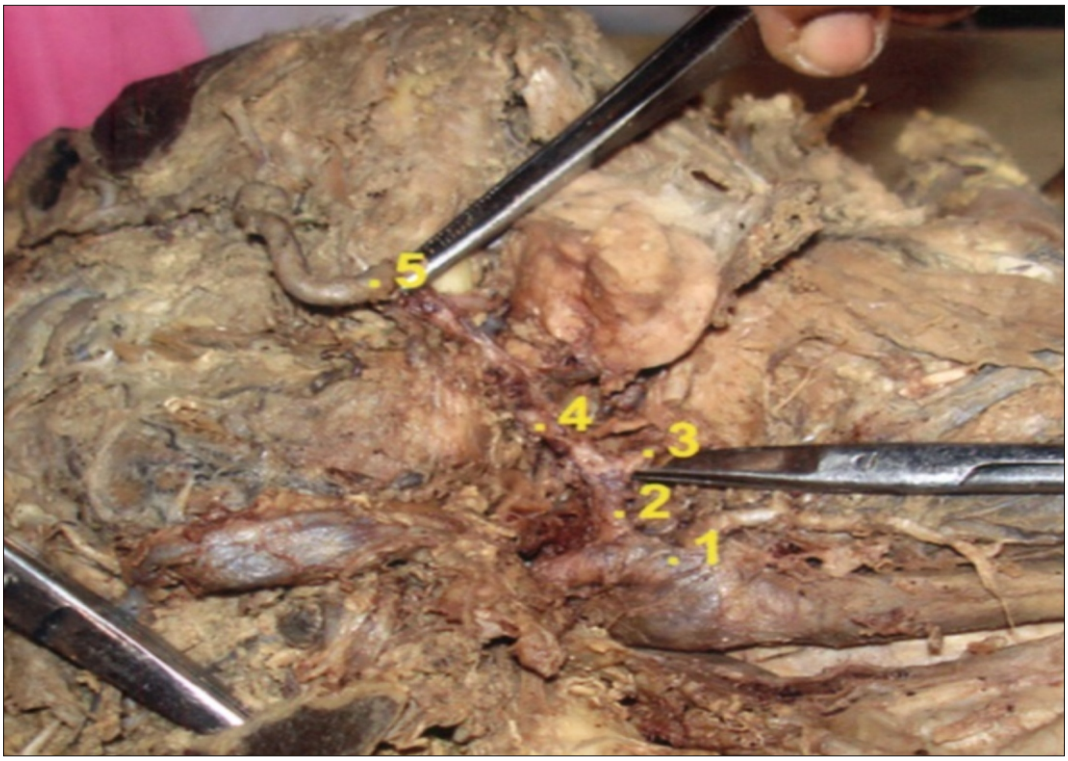

1.ECA 2.LA 3.FA

**Fig 3 : Origin of FA as CLF trunk**




1.ECA 2.CLF trunk 3.LA 4.FA

**Fig 4 : Origin of FA as CLF trunk**




1.ECA 2.CLF trunk 3.LA 4.FA. 5FA

# OBSERVATION

## DISSECTION METHOD

Facial arteries in 50 hemifaces preserved in formalin were studied by conventional dissection method. The main trunk was studied for its mode of origin from the ECA, either as separate trunk or common trunk with LA, level of origin in relation to the CB, point of entry into the face in relation to the angle of mandible , branching pattern and mode of termination in face. The submental and perioral branches were studied for its length and origin in relation to the origin of FA or OC.

## FACIAL ARTERY (MAIN TRUNK)

## MODE OF ORIGIN

Separate origin of facial artery from the external carotid artery was observed in 41 hemifaces (82%) [Fig 1,2]

Common linguo facial trunk was observed in 9 hemifaces (18%).The CLF trunk was present bilaterally in 3 cadavers (12%) [Fig 3,4 ]

## Table 1 : Mode of origin of FA from ECA

| Mode of origin of FA from ECA | Incidence | Percentage |
|---|---|---|
| Separate origin | 41 | 82 % |
| CLF trunk | 9 | 18 % |

## Chart 1 : Mode of origin of FA from ECA

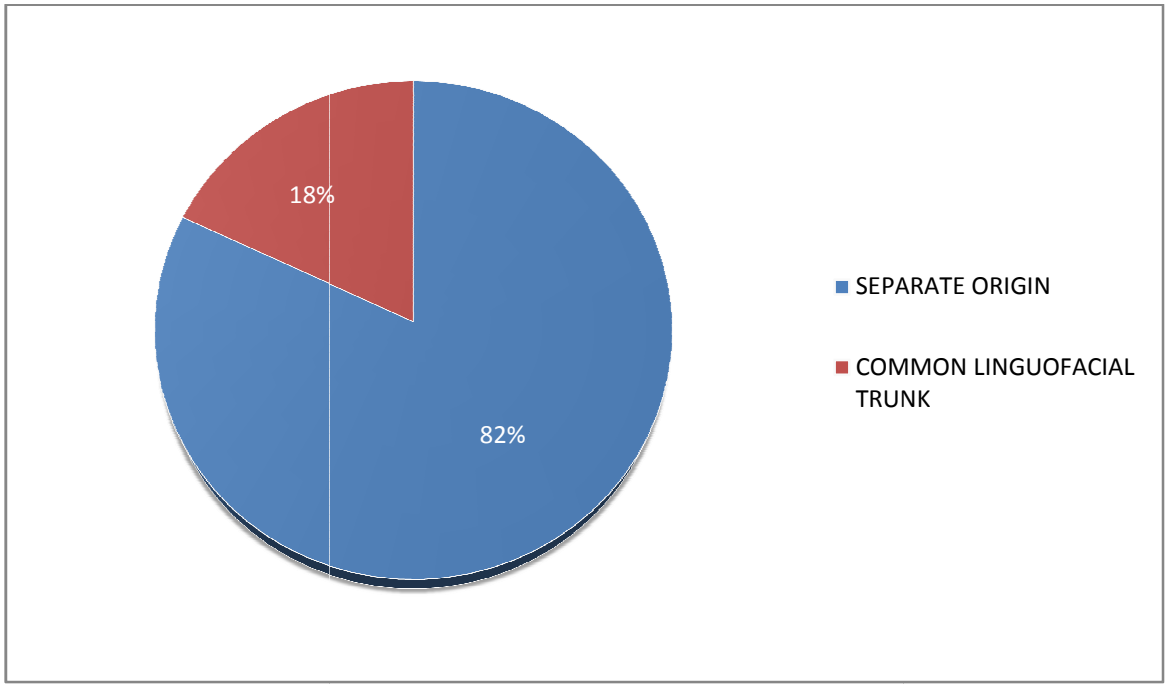
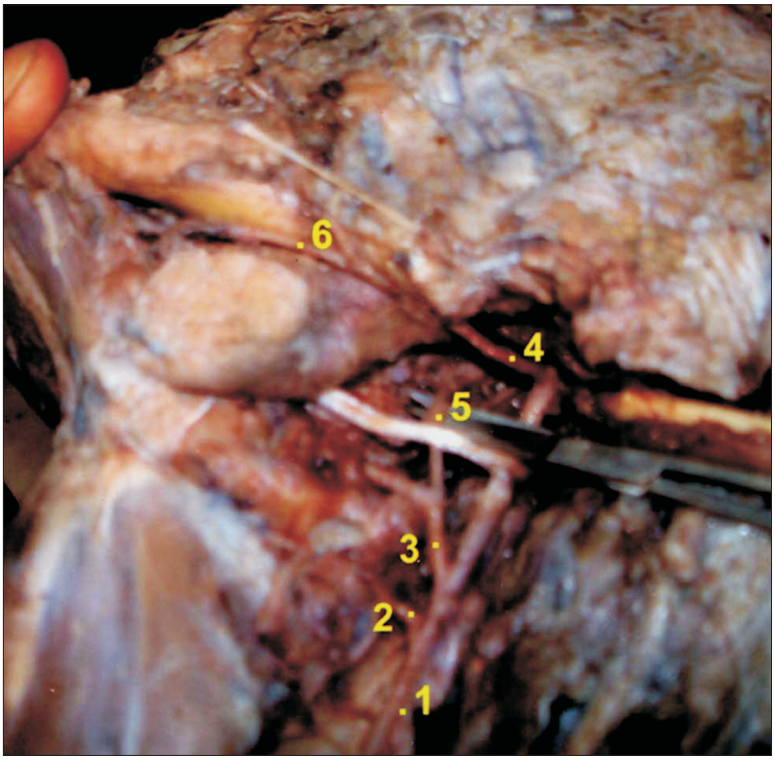


**Fig 5 : High origin of FA**




1.ECA 2.STA 3. LA 4.FA 5.LA 6.SMA

**Fig 6 : Low origin of CLF trunk**


1.ECA 2.CLF trunk 3. FA 4.LA

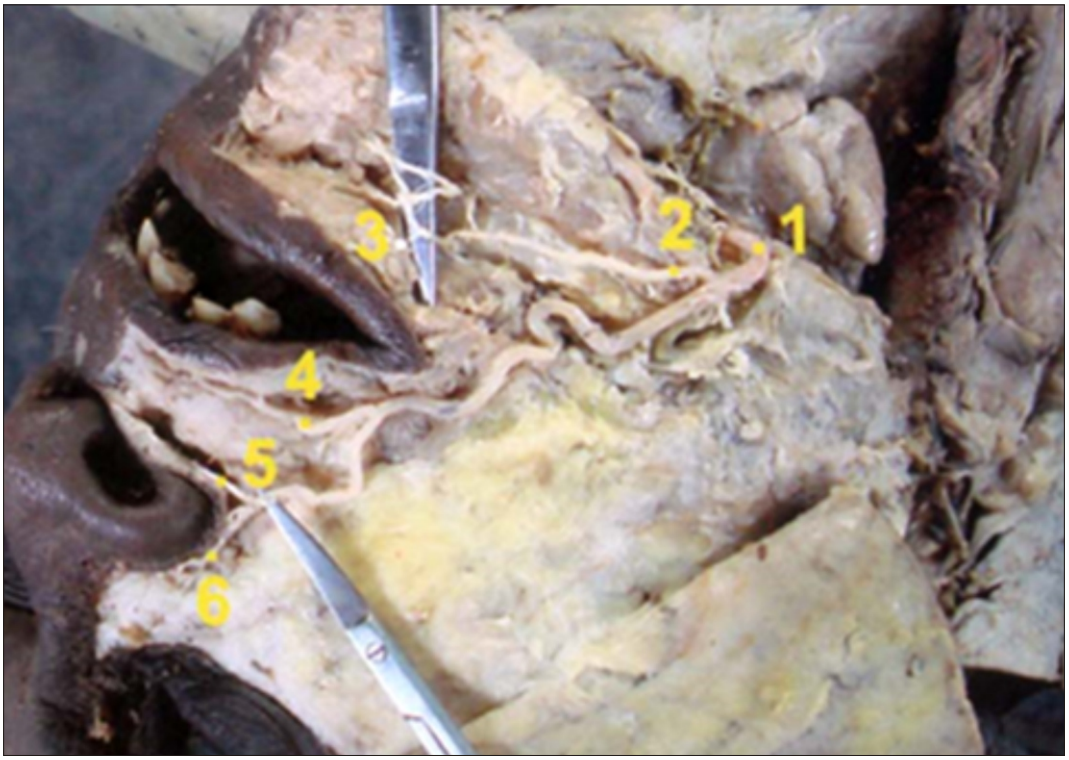
## LEVEL OF ORIGIN

The average distance of FA trunk or the CLF trunk from the CB was 1.65 cm. In one case the FA arose high just above the angle of mandible, 4.7 cm from the CB [Fig 5]. In one case the CLF trunk originated low from the ECA, 0.1 cm from the CB [Fig 6]

**Table 2 : Distance of origin of FA or CLF from CB**

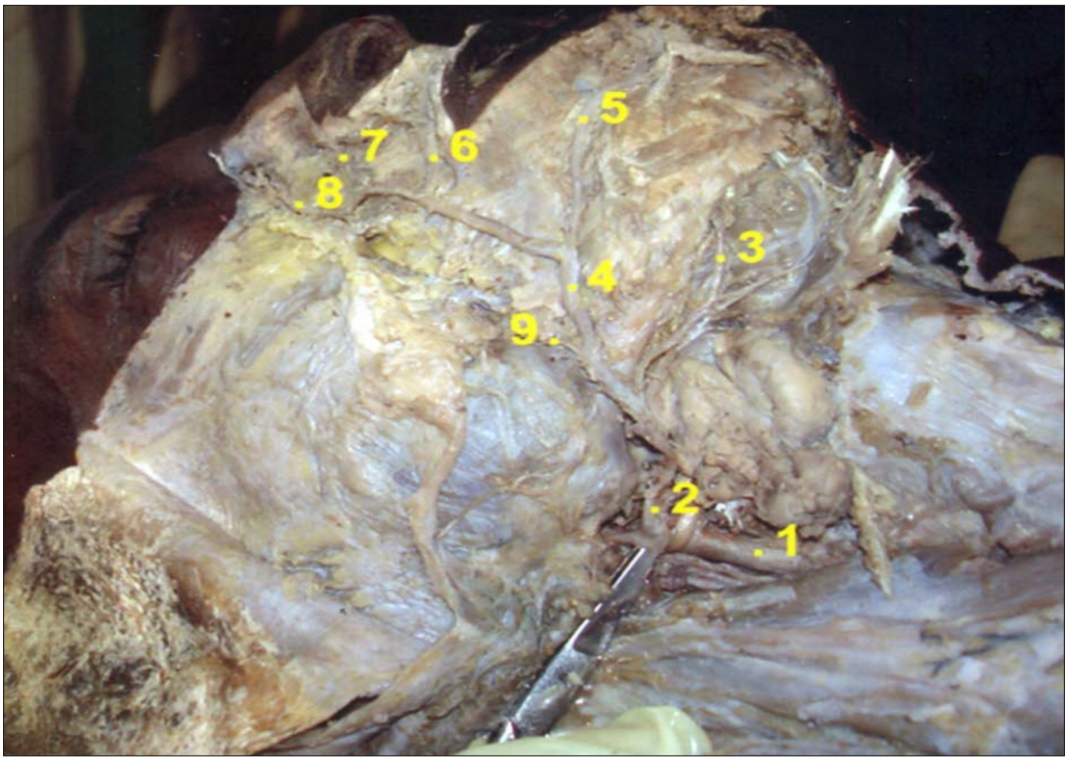
| Measurements | Distance in cm |
|---|---|
| Minimum distance | 0.1 |
| Maximum distance | 4.7 |
| Mean distance | 1.65 |

**Fig 7 : Branches of FA in face**



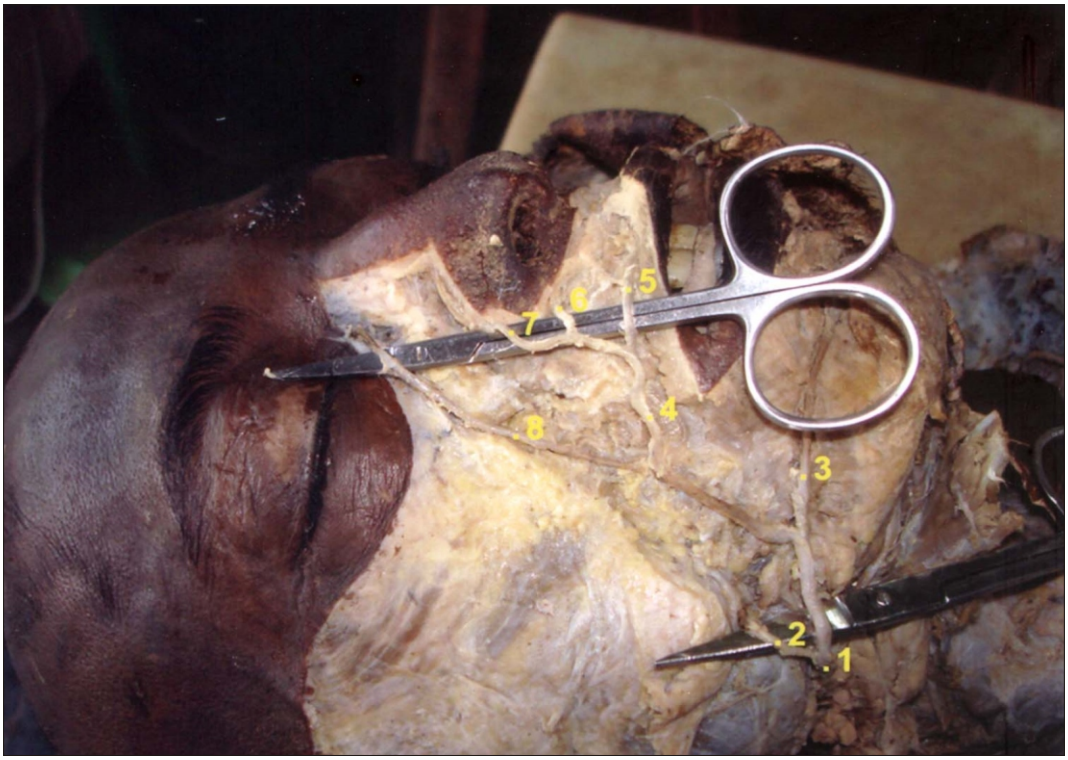

**1.FA 2,3.ILA 4 .SLA 5. IAA 6.LNA**

**Fig 8 : Type A branching pattern [ FA terminating as AA ]**



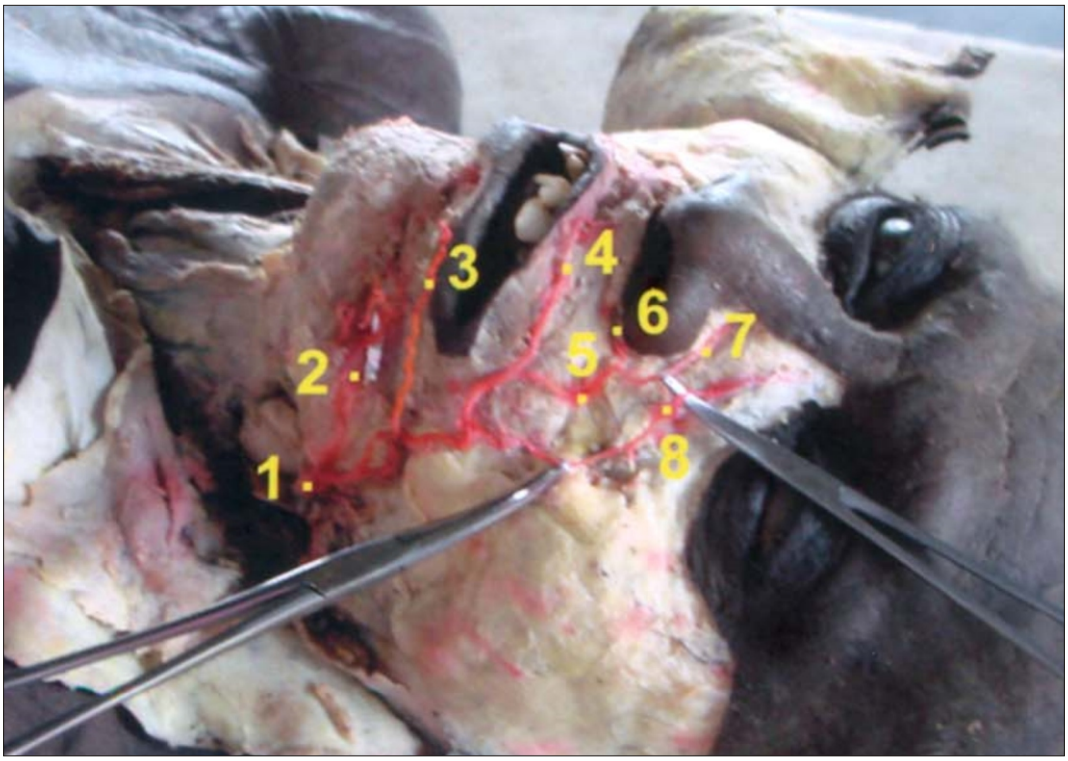

**1.ECA 2.FA 3.SMA 4.FA in face 5.ILA 6.SLA 7.LNA 8.AA 9.PMA**

**Fig 9 : Type A - Origin of SLA and LNA**
**[ From common trunk ]**




1.FA 2.PA 3.ILA 4. common trunk for SLA and LNA
5.SLA 6.IAA 7.LNA 8.AA

**Fig 10 : Type A LNA arising from SLA**




1.FA 2,3.ILA 4.SLA 5.LNA 6.IAA 7.SAA

## DISTANCE OF FACIAL ARTERY CROSSING THE MANDIBULAR MARGIN FROM THE ANGLE OF MANDIBLE.

The average distance was 2.95 cm with a range of 2.5 cm – 3.3 cm.

**Table 3: Distance of FA crossing the MM from MA**

| Measurements | Distance in cm |
|---|---|
| Minimum distance | 2.5 |
| Maximum distance | 3.3 |
| Mean distance | 2.95 |

## BRANCHING PATTERN OF FACIAL ARTERY IN THE FACE.

The branching pattern of FA in face was classified based on the study done by Loukas et al.

**Type A:** In 35 hemifaces, the FA continued as AA (70 %).

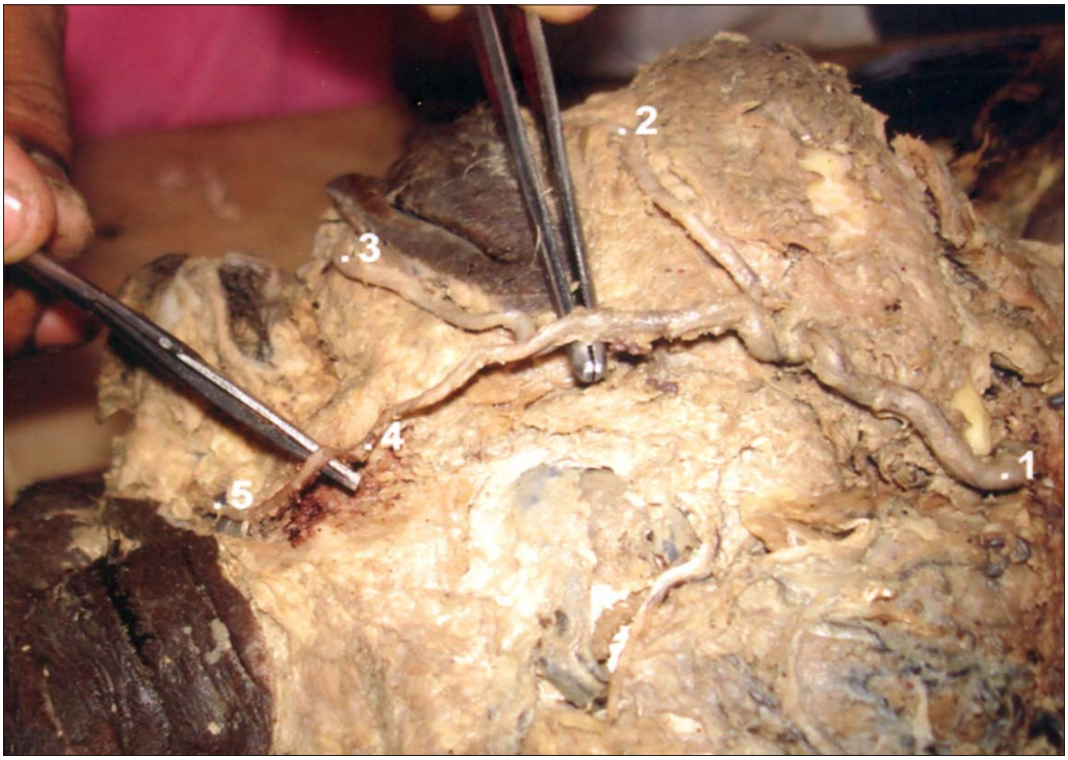
Out of the 35 specimens belonging to type A,

in 24 specimens, FA gave rise to SLA, LNA and continued as AA [Fig 8].

In 5 cases, the SLA and LNA arose from a common trunk.[Fig 9]

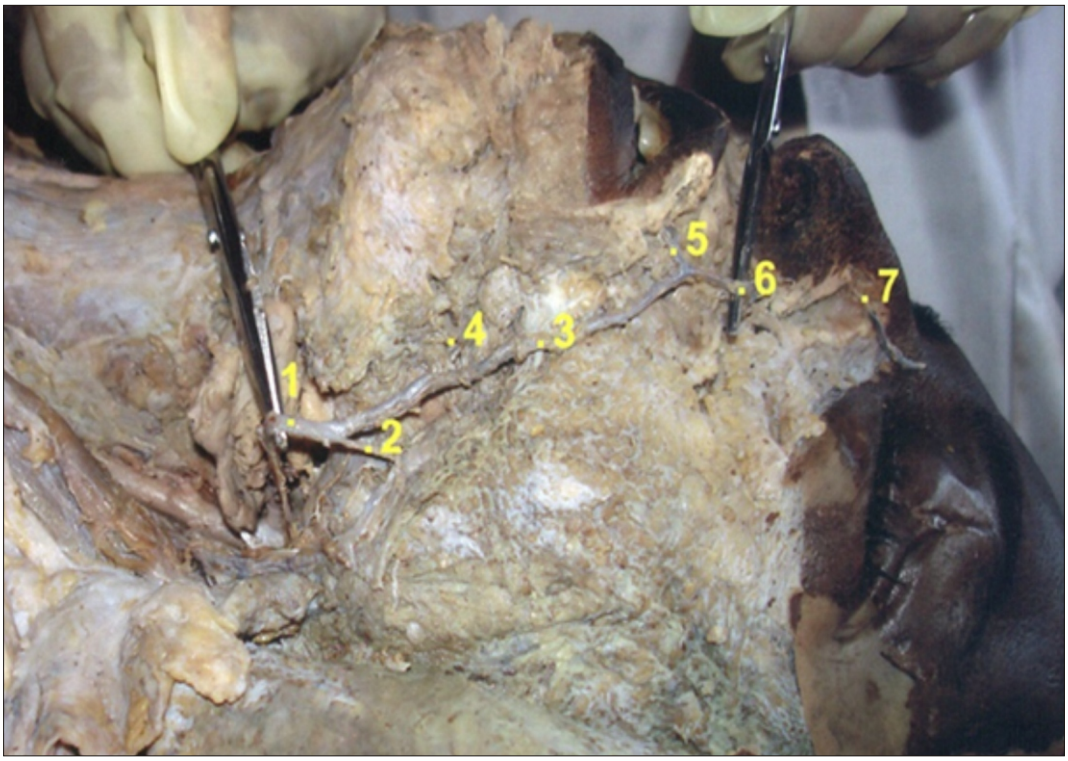
In 4 specimens, LNA arose from SLA .[Fig 10]

**Fig 11 : Type A with absent LNA**




1.FA 2.ILA 3.SLA 4.AA 5.AA

**Fig 12 : Premasseteric branch in type A FA**

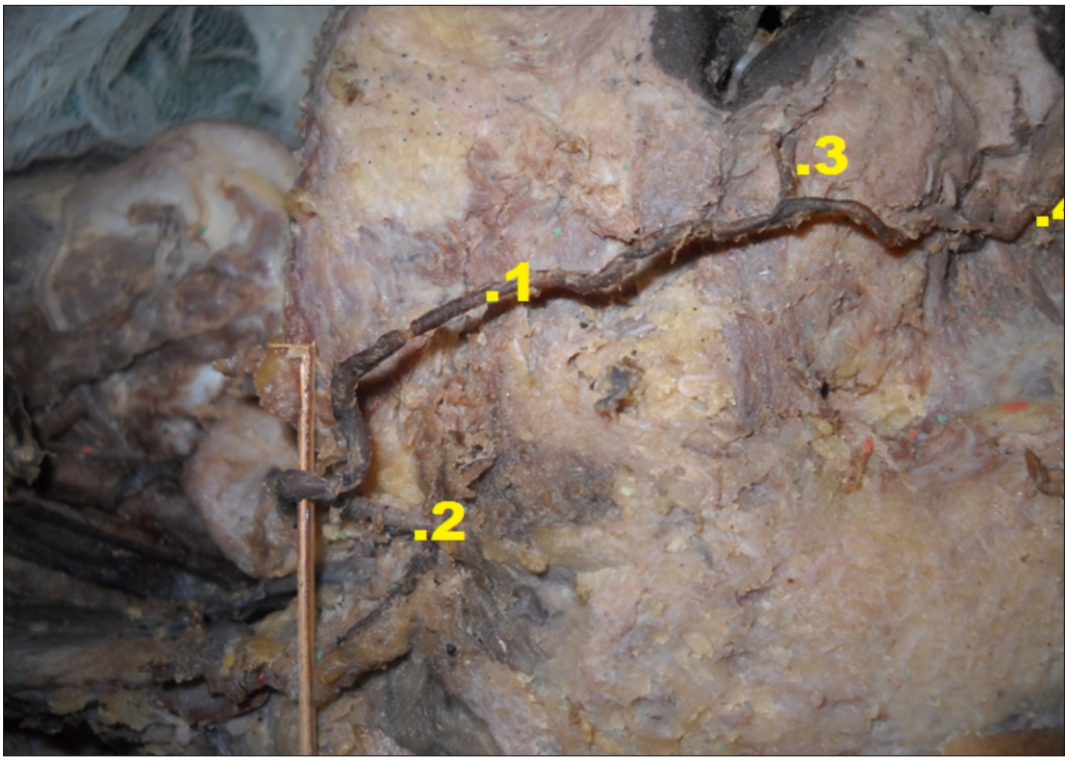



1.FA 2.PMA 3.FA 4.ILA 5.SLA 6.LNA 7.AA

**Fig 13 : Type B branching pattern**
**[ FA terminating as LNA ]**


1.ECA 2.FA 3.SMA 4.ILA 5.SLA. 6,7.LNA.

**Fig 14 : Premasseteric branch in type B FA**




1.FA 2.PMA 3.SLA 4.LNA

In 2 specimens, LNA was absent and FA continued as AA after giving SLA [Fig 11]

In 7 FA of type A pattern, premasseteric branch was present in addition to the labial and nasal branches [Fig 12]. Buccal branch was present in 2 specimens.

**Type B** : FA gave origin to SLA and LNA. AA was absent. Type B was observed in 12 hemifaces (24%).[Fig 13]

In 4 FA of type B pattern , premasseteric branch was present.[Fig 14]

In 4 FA of type B pattern, buccal branch was present.[Fig 15]

**Type C** : 3 FA (6%) ended as SLA .The AA and LNA were absent.

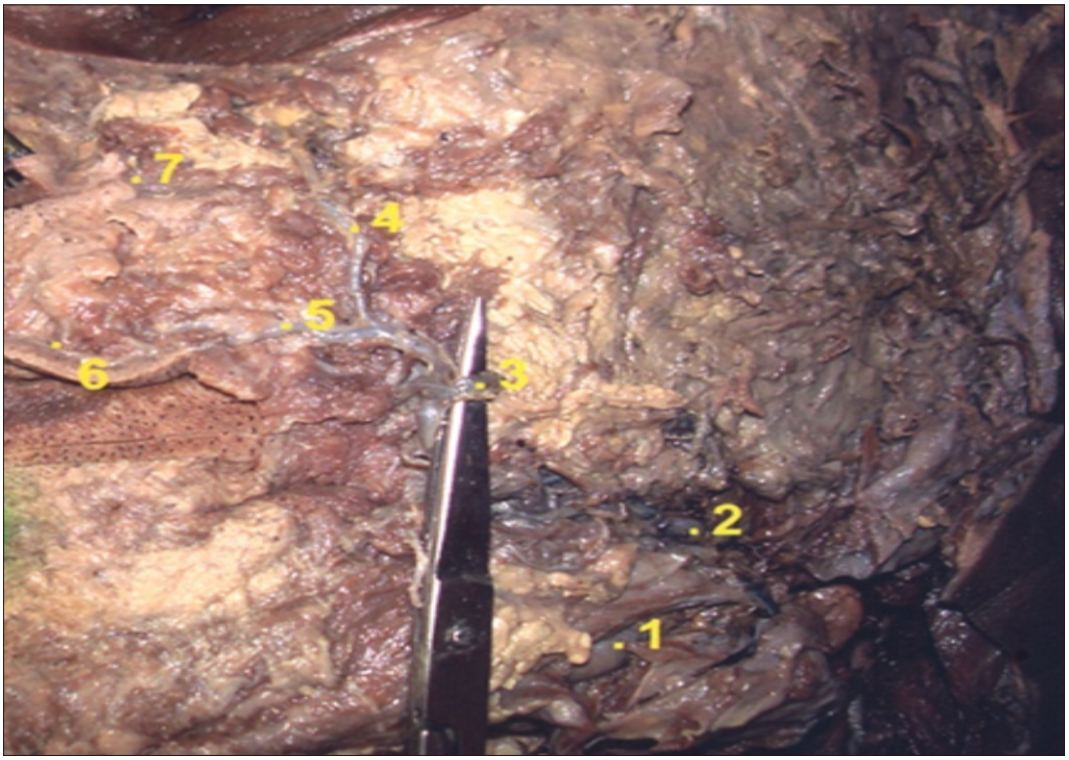
Out of the three FA belonging to type C, in 2 cases twigs from SLA anastomosed with branches from infra orbital artery.[Fig 16]

In 1 specimen, SLA gave rise to inferior alar artey.[Fig 17].

In all the specimens of type C pattern, premasseteric branch was present.

Out of the total 50 specimens, premasseteric branch was found in 14 hemifaces (28 %) and buccal branch was present in 6 hemifaces (12%).

**Fig 15 : Buccal branch of type B FA**

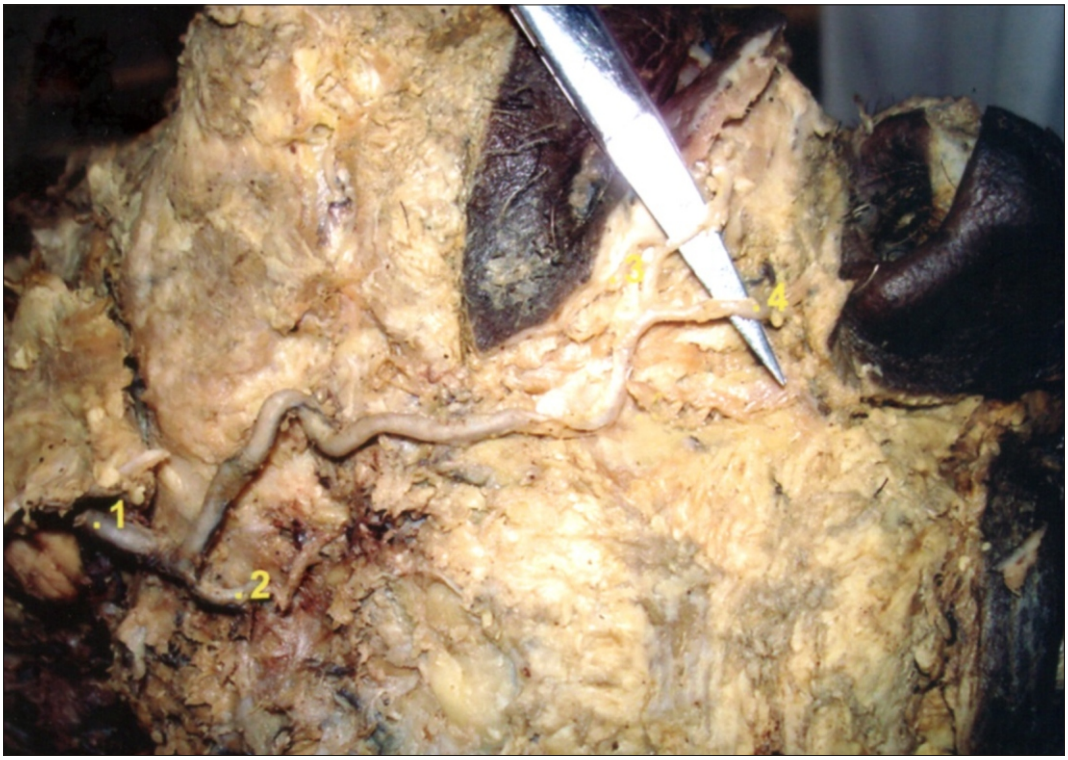



1.SMA 2.FA 3.BA 4.FA 5,6.SLA 7.LNA

**Fig 16 : Type C branching pattern**
**[ FA terminating as SLA ]**

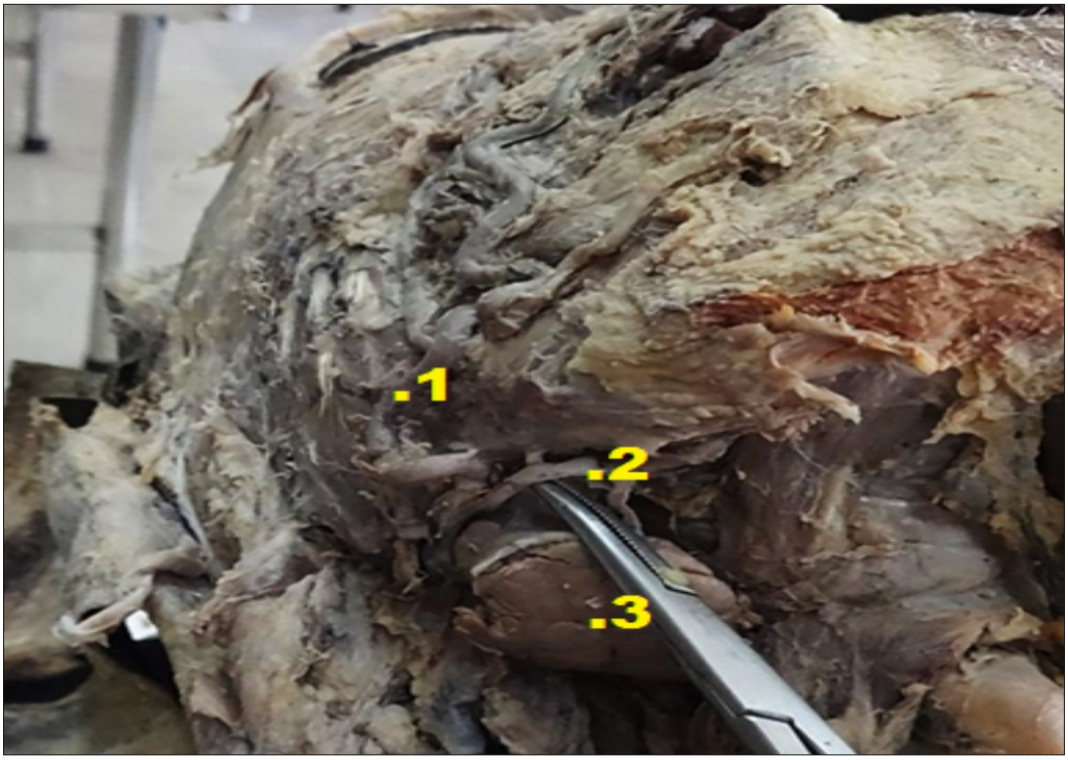

1.FA 2.PMA 3.ILA 4,5 SLA
6.ANASTOMOSING TWIG 7.INFRAORBITAL ARTERY

**Fig 17 : Type C - IAA arising from SLA**




1.FA 2.PMA 3.SLA 4.IAA

**Fig 18 : Submental artery**

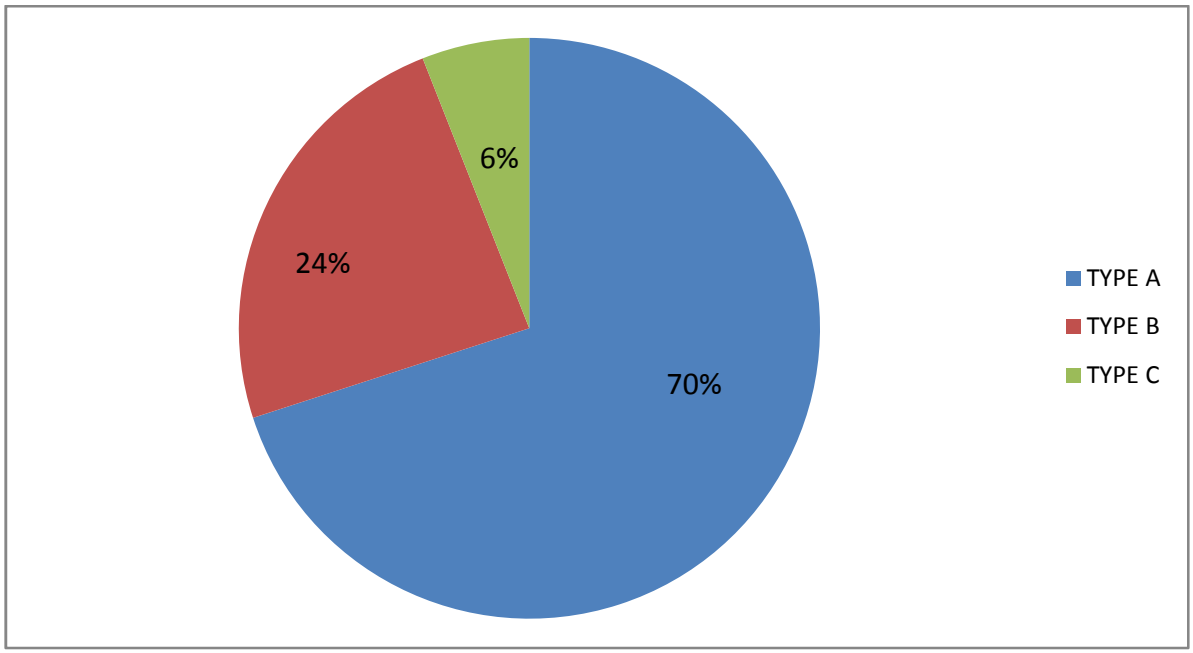



1.FA 2.SMA 3.SMG

**Table 4 : Branching pattern of FA in face**

| Branching pattern | Frequency | Percentage |
|---|---|---|
| A | 35 | 70% |
| B | 12 | 24% |
| C | 3 | 6% |

**Chart 2 : Branching pattern of FA in face**



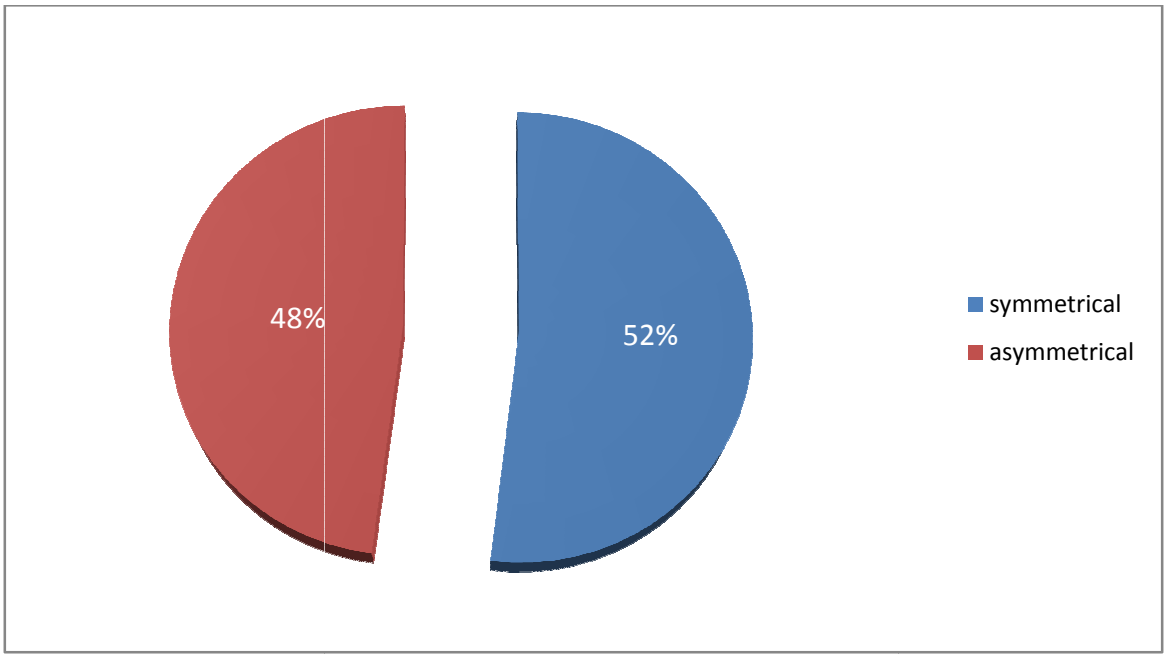
## SYMMETRY IN THE BRANCHING PATTERN OF FACIAL ARTERY IN FACE

The branches of FA in the face and neck on both sides were identical and same in number and termination in 13 cadavers (52 %) . In 12 cadavers thethe branching pattern and termination varied from side to side**.**

**Table 5 : Symmetry in the branching pattern of FA in face**

| Branching pattern in face | Frequency | Percentage |
|---|---|---|
| Symmetrical | 13 | 52% |
| Asymmetrical | 12 | 48% |

**Chart 3: Symmetry in the branching pattern of FA in face**



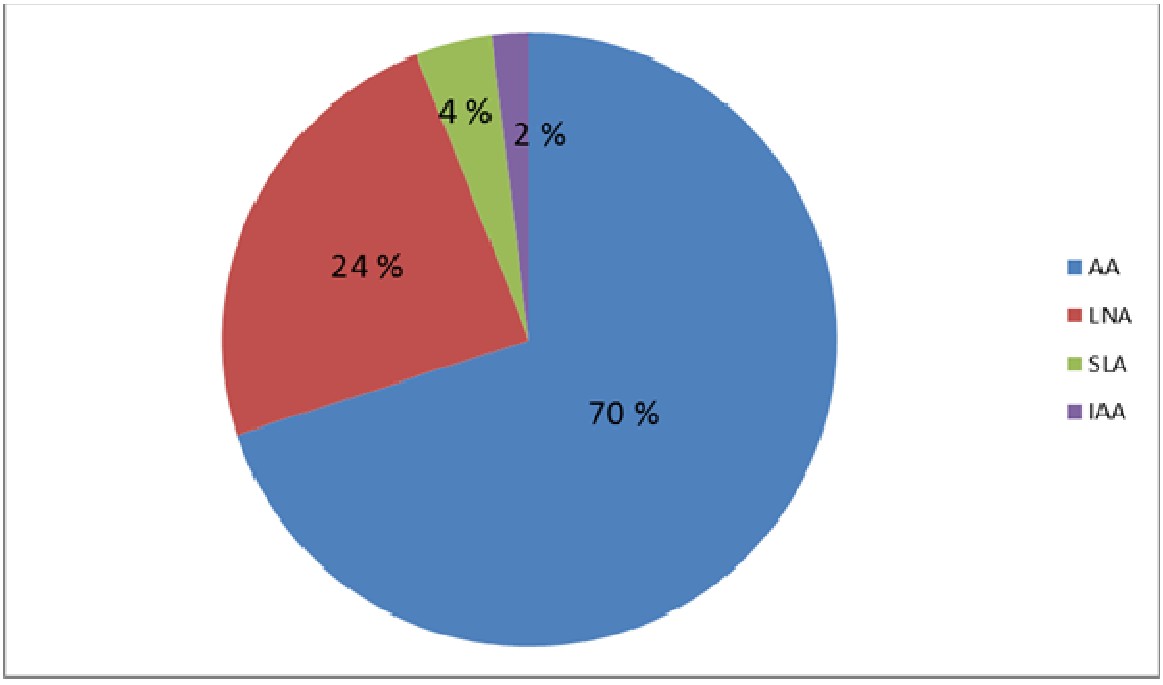
## MODE OF TERMINATION OF FACIAL ARTERY.

The FA terminated as AA in 35 specimens (70%), LNA in 12 cases (24%) as SLA in 2 hemifaces (4%) and as IAA in 1 specimen (2%).

**Table 6 : Mode of termination of FA**

| Terminating artery | Frequency | Percentage |
|---|---|---|
| AA | 35 | 70% |
| LNA | 12 | 24% |
| SLA | 2 | 4% |
| IAA | 1 | 2 % |

**Chart 4 : Mode of termination of FA**



## SUBMENTAL ARTERY

### LENGTH OF SUBMENTAL ARTERY

The average length was 7.44 cm with a range of 5.5 cm - 9.1cm.[Fig 18]

**Table 7: Length of submental artery**

| Measurements | Length in cm |
|---|---|
| Minimum length | 5.5 |
| Maximum length | 9.1 |
| Mean length | 7.44 |

### DISTANCE OF ORIGIN OF SUBMENTAL ARTERY FROM ORIGIN OF FACIAL ARTERY

The mean distance was 3.36 cm , the values varying from 3cm to 3.9 cm.

**Table 8 : Distance of origin of SMA from the origin of FA**

| Measurements | Distance in cm |
|---|---|
| Minimum distance | 3.0 |
| Maximum distance | 3.9 |
| Mean distance | 3.36 |

## DISTANCE OF ORIGIN OF SUBMENTAL ARTERY FROM THE ANGLEOF MANDIBLE

The values varied from 2.1cm to 3.5 cm with a mean distance of 2.88cm.

**Table 9: Distance of SMA from MA**

| Measurements | Distance in cm |
|---|---|
| Minimum distance | 2.1 |
| Maximum distance | 3.5 |
| Mean distance | 2.88 |

## INFRA LABIAL ARTERY

## INCIDENCE OF INFRA LABIAL ARTERY

When two ILA were present the proximal one was termed as infra labial or sublabial branch. It arose separately from the FA in all cases. The Infra labial arteries ended by anastomosing with opposite side arteries or mental branch of SMA.

The Infra labial artery was found in 29 hemifaces (58%).[Fig 19]

## LENGTH OF INFRA LABIAL ARTERY

This was measured from the point of its origin to its termination in the midline. The average length, measured was 2.48 cm.

**Table 10 : Length of infra labial artery**

| Measurements | Length in cm |
|---|---|
| Minimum length | 2.0 |
| Maximum length | 3.3 |
| Mean length | 2.48 |

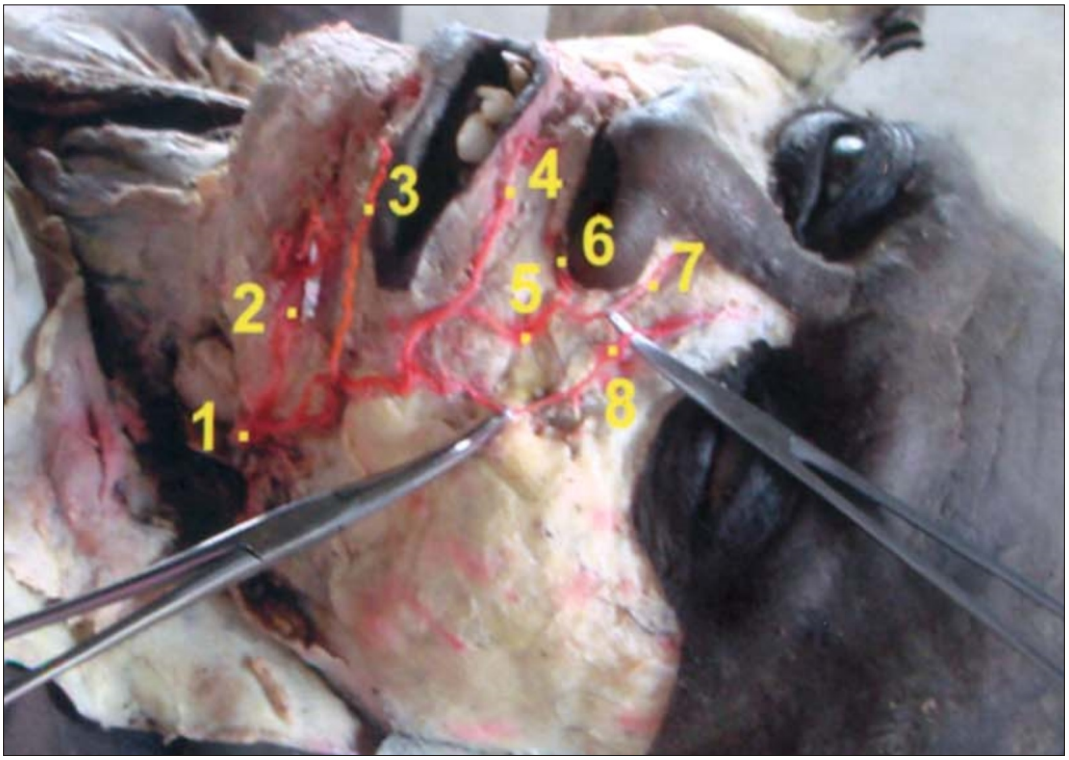
## DISTANCE OF ORIGIN OF INFRALABIAL ARTERY FROM THE ORAL COMMISSURE

The mean distance was 2.87 cm with a minimum of 2.1 cm and a maximum of 3.2 cm.

**Table 11 : Distance of origin of Infra Labial Artery from the OC**

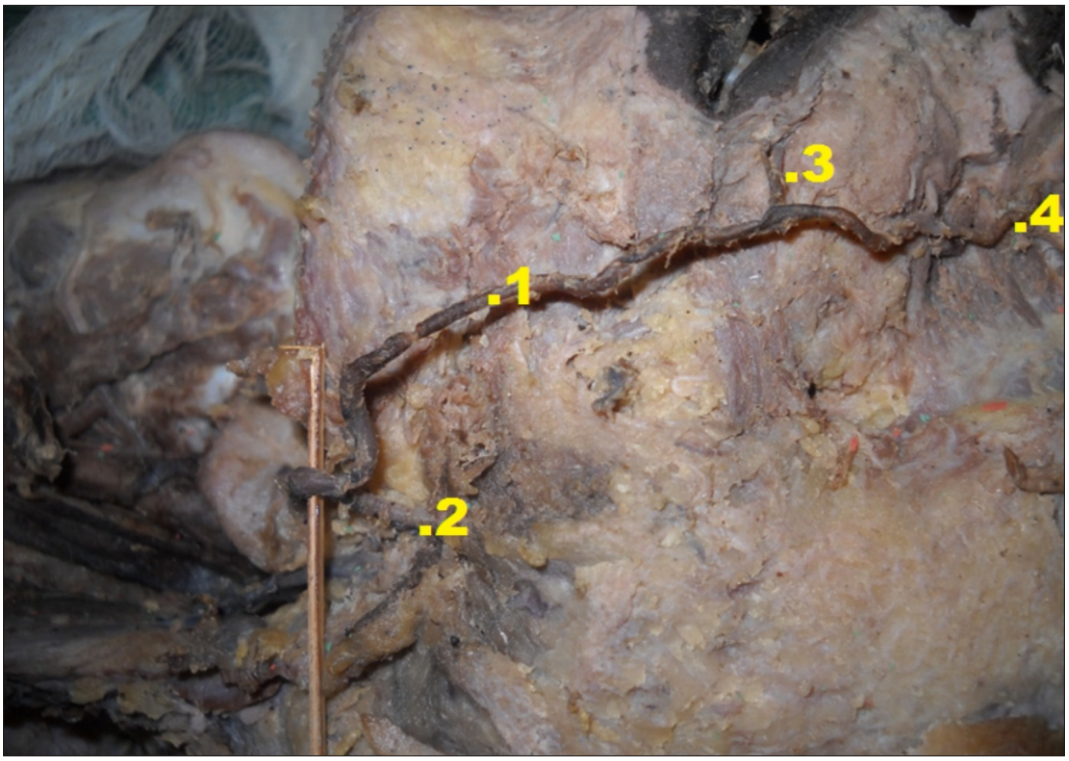
| Measurements | Distance in cm |
|---|---|
| Minimum distance | 2.1 |
| Maximum distance | 3.2 |
| Mean distance | 2.87 |

**Fig 19 : Infra labial artery**




1.FA 2.Infra labial artery 3.ILA 4.SLA
5.LNA 6.IAA 7.SAA. 8.AA

**Fig 20 : Absent ILA**




1.FA 2.PMA 3.SLA 4.LNA

## INFERIOR LABIAL ARTERY

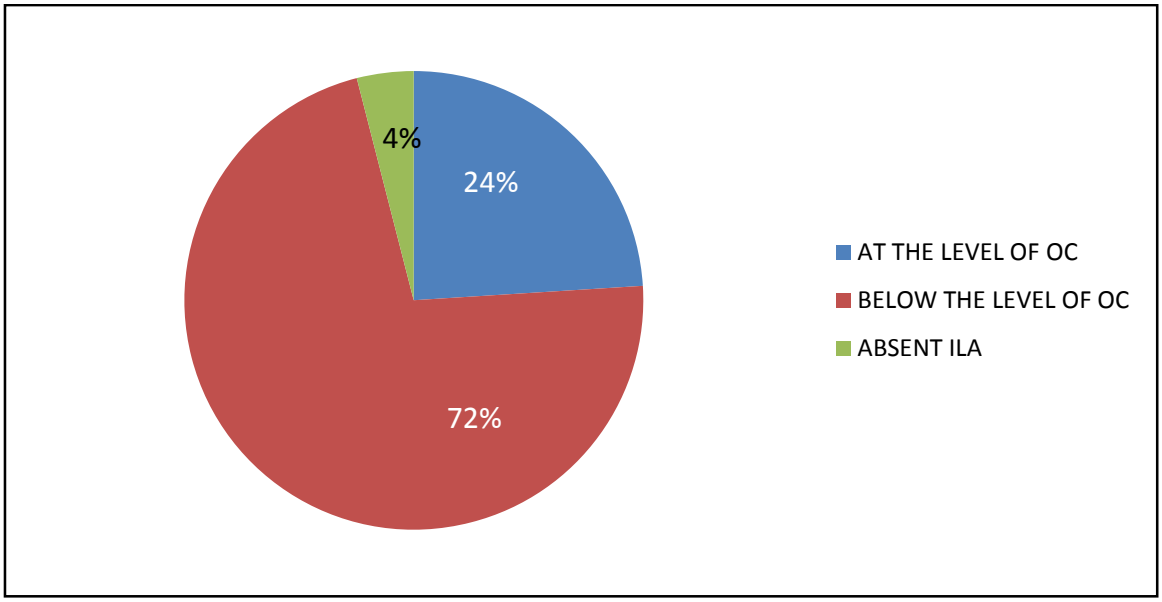
### ORIGIN OF INFERIOR LABIAL ARTERY IN RELATION TO THE ORAL COMMISSURE.

12 ILA (24 %) arose from FA at the level of OC, 36 ILA arose from FA below the level of OC (72%).ILA was absent in 2 cases (4%)[Fig 20].

**Table 12 : Origin of ILA in relation to the OC**

| Origin of ILA | Frequency | Percentage |
|---|---|---|
| At OC | 12 | 24 % |
| Below OC | 36 | 72% |
| Absent ILA | 2 | 4% |

**Chart 5 : Origin of ILA in relation to the OC.**



## DISTANCE OF ORIGIN OF INFERIOR LABIAL ARTERY FROM THE ORAL COMMISSURE.

The average distance was 2.48 cm with a range of 0.8 cm to 4.2 cm.

**Table 13 : Distance of origin of ILA from OC**

| Measurement | Distance in cms |
|---|---|
| Minimum distance | 0.8 |
| Maximum distance | 4.2 |
| Mean distance | 2.48 |

## LENGTH OF INFERIOR LABIAL ARTERY

The mean length of ILA was measured as 5.96 cm with a minimum length of 3.9 cm and a maximum length of 7.8 cm.

**Table 14: Length of inferior labial artery**

| Measurements | Length in cm |
|---|---|
| Minimum length | 3.9 |
| Maximum length | 7.8 |
| Mean length | 5.96 |

## SUPERIOR LABIAL ARTERY

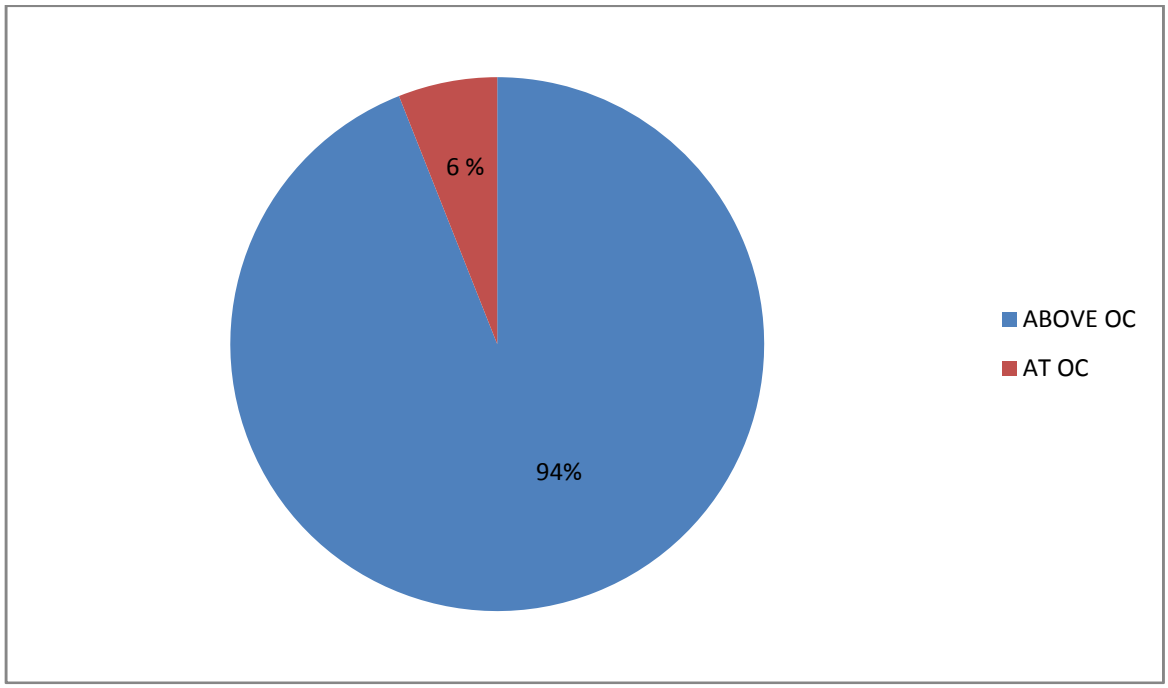
## ORIGIN OF SUPERIOR LABIAL ARTERY IN RELATION TO THE ORAL COMMISSURE.

47 SLA (94%) arose from FA above the level of OC, in 3 cases (6%) it arose at the level of OC.

**Table 15 : Origin of SLA in relation to the OC**

| Origin of SLA | Frequency | Percentage |
|---|---|---|
| Above the level of OC | 47 | 94 % |
| At the level of OC | 3 | 6% |

**Chart 6: Origin of SLA in relation to the OC**



**DISTANCE OF ORIGIN OF SUPERIOR LABIAL ARTERY FROM THE ORAL COMMISSURE.**

The average distance was 1.47 cm with a range of 0.6 cm to 2.3 cm

**Table 16 : Distance of origin of SLA from the OC**

| Measurements | Distance in cm |
|---|---|
| Minimum length | 0.6 |
| Maximum length | 2.3 |
| Mean length | 1.47 |

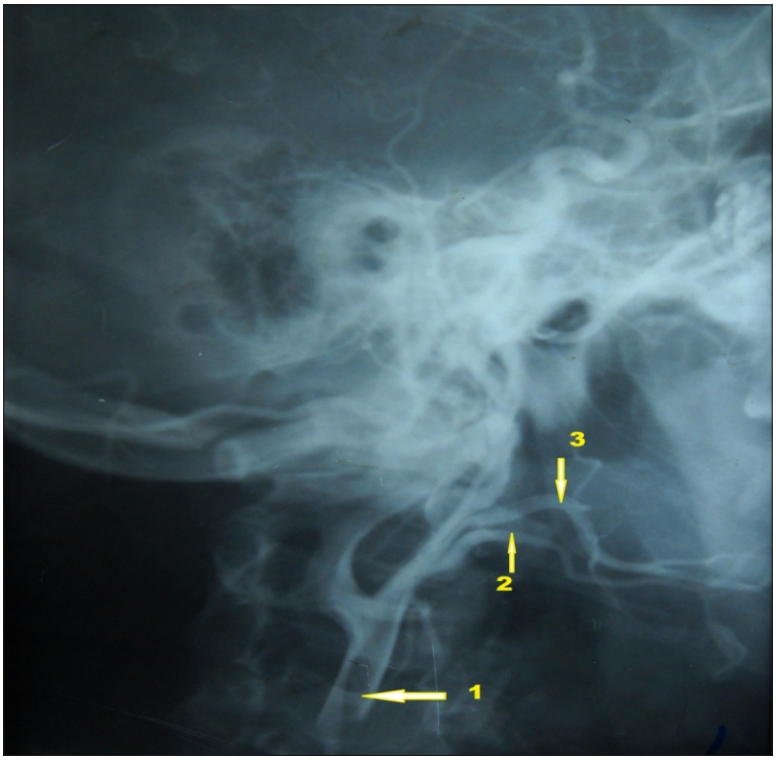
**LENGTH OF SUPERIOR LABIAL ARTERY**.

The length varied from 4 cm to 8.3 cm and the average length was 6.04 cm.

**Table 17: Length of SLA**

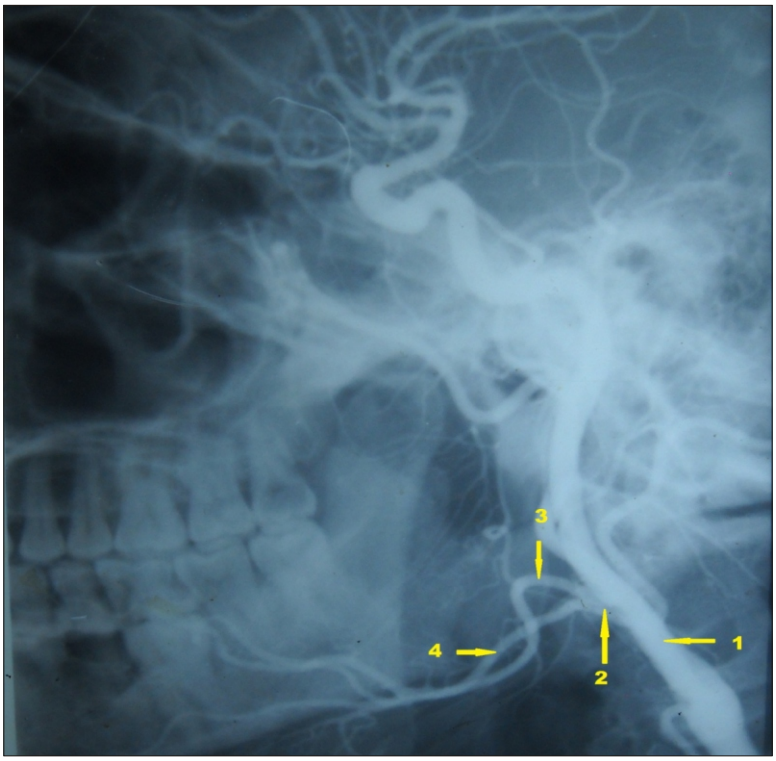
| Measurements | Length in cms |
|---|---|
| Minimum length | 4.0 |
| Maximum length | 8.3 |
| Mean length | 6.04 |

**Fig 21 : Normal Carotid Angiogram**



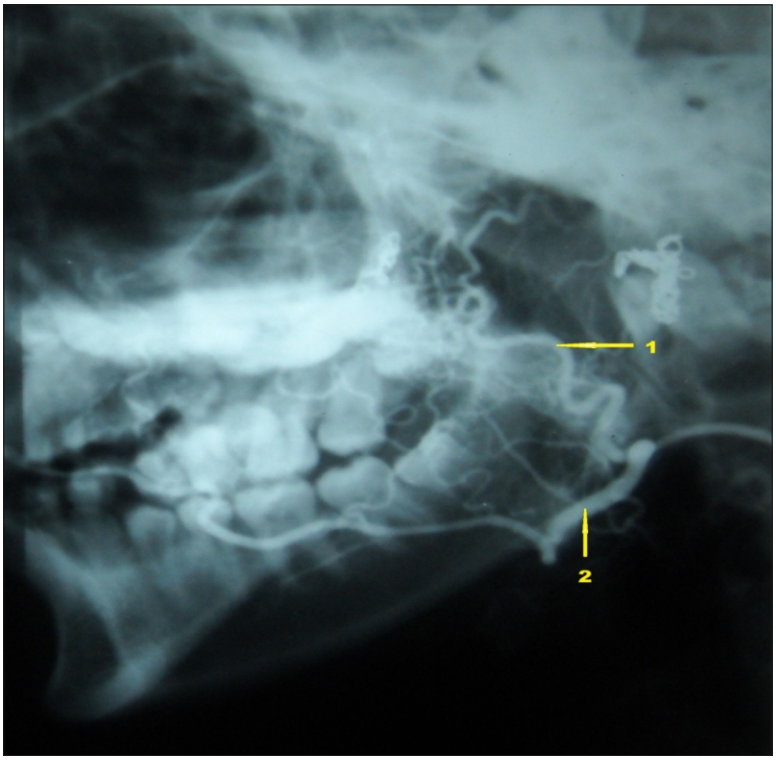

1.ECA 2 .LA 3.FA

**Fig 22 : Carotid Angiogram showing CLF trunk**



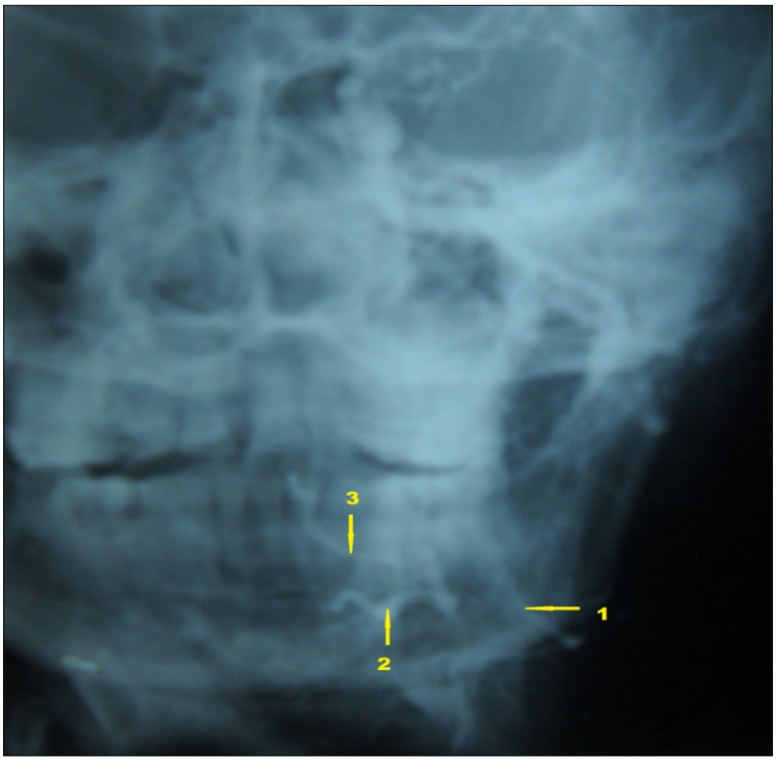

1.ECA 2.CLF trunk 3.FA 4.LA

**Fig 23 : Normal Carotid Angiogram**




1. FA 2. SMA

**Fig 24 :Carotid Angiogram showing Infra labial artery**




1.FA 2. Infra labial artery 3. ILA

## RADIOLOGICAL METHOD

Out of the 15 carotid angiograms , one FA had common linguofacial trunk (6.66 %) (Fig 22).Other FA had separate origin from ECA (93.33 %) (Fig 21). 8 FA had infra labial artery (53.33%) (Fig 24) .

# *Discussion*

# DISCUSSION

## FACIAL ARTERY (MAIN TRUNK)

### MODE OF ORIGIN

**Midy et al [31] [1986]** reported separate origin of FA in 92.5 % cases and CLF in 7.5 % cases.

**Ozgur et al [39] [2008]** observed that 92.5 % ECA gave separate origin to FA and 7.5 % ECA gave origin to CLF trunk.

**Fazan et al [11] [2009]** observed separate origin of FA in 78 % cases and origin from a CLF in 22 % cases. 4.8 % of cadavers had bilateral CLF trunk.

**Lohn et al [24] [2011]** reported separate origin of FA from external carotid artery in 86% and common linguofacial trunk in 14% .

**Troupis et al [50] [2011]** reported an unilateral CLF trunk out of 15 on the right side of a cadaver. The length of the CLF trunk was 0.73 cm before it bifurcated into FA and LA.

**Mata et al [30] [2012]** reported that 77.8 % of FA had separate origin from ECA and 19.9 % of FA had a common origin with lingual artery as linguofacial trunk. The CLF trunk was commoner than other combined arterial trunks of ECA.

**S.Dnyanesh et al [48] [2013]** reported a case of unilateral CLF trunk during their routine dissection. The length of the CLF trunk was 1.2 cm.

In the **present study,** FA in 41 hemifaces (82%) had a separate origin from the ECA. In 9 hemifaces (18%), CLF was observed. In 3 cadavers (12%) the CLF trunk was present bilaterally.

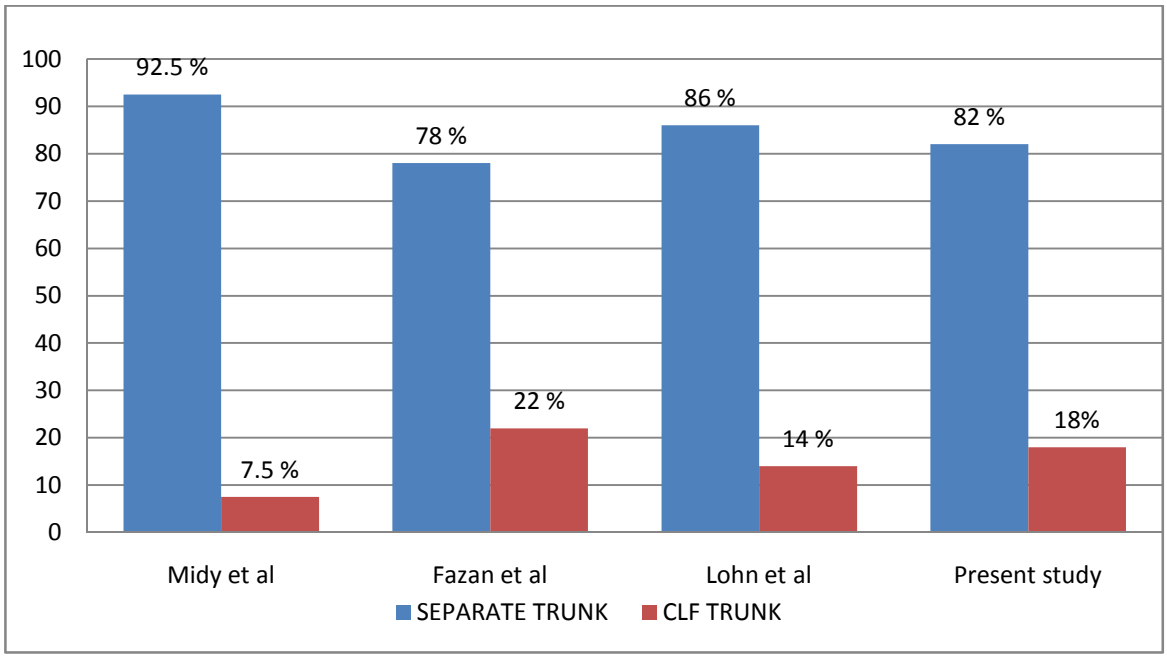
In all the above studies,compared the incidence of separate origin of FA from ECA was more than the CLF trunk and the incidence of CLF trunk is below 25%. This coincides with the present study. In the present study bilateral CLF trunk is more common than unilateral CLF trunk which differs from Fazan et al where unilateral CLF trunk is more common.

The knowledge of the linguo facial trunk is important when performing extra oral lingual artery ligation. Ligation of LA in such cases can reduce the blood flow to facial structures. The presence of CLF trunk can cause technical difficulty during carotid artery catheterisation .The knowledge of CLF trunk is also essential for radiologists to understand and interpret the carotid system imaging.

## Table 18 : Mode of origin of FA from ECA

| Mode of origin | Midy et al [1986] | Fazan et al [2009] | Lohn et al [2011] | Present study |
|---|---|---|---|---|
| **Separate** | 92.5% | 78% | 86% | 82% |
| **CLF trunk** | 7.5% | 22% | 14% | 18% |

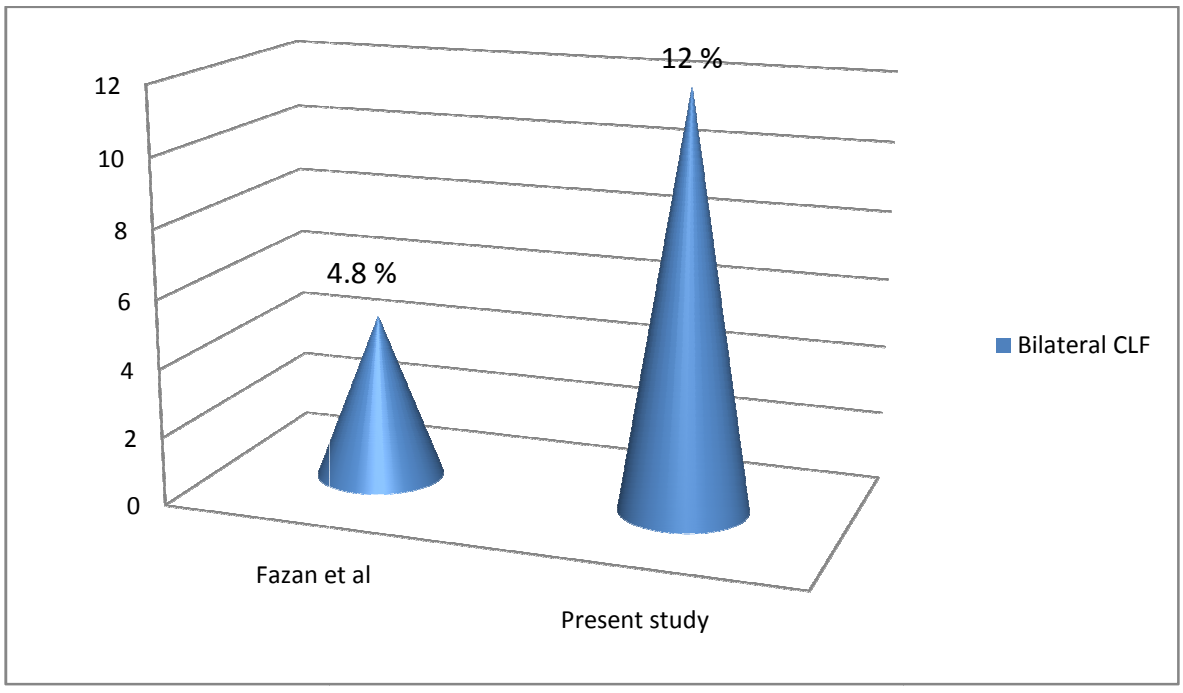
## Chart 7 : Mode of origin of FA from ECA



## Table 19 : Incidence of bilateral CLF trunk

| Studies | Incidence |
|---|---|
| Fazan et al [2009] | 4.8 % |
| Present study | 12 % |

## Chart 8: Incidence of bilateral CLF trunk



## LEVEL OF ORIGIN

**George A Piersol [15] [1930]** has quoted that FA can arise above the angle of jaw**.**

**Midy et al [31] [1986]** measured the origin of FA from the carotid bifurcation which was 1cm -3.5 cm.

**S.Nayak [36] [2006]** reported a case of an abnormal origin of FA in the substance of parotid gland .

**Jiang et al [20] [2008]** measured the distance of FA from CB using spiral CT angiography. The average distance was 0. 45 – 4.79 cm (mean 1.87 -/+ 0.89 cm) on the right side and 0.68-3.97 cm (mean 1.92 -/+ 0.82 cm) on the left side.

**Mohandas Rao et al[32] [2009]** reported a case where FA originated high in the digastric triangle, 5 cm above the carotid bifurcation.

**Mamatha et al [29] [2010]** reported a variation where FA originated 2.9cm above the CB, 1.5 cm above the posterior belly of digastric ,in the digastric triangle**.**

**Troupis et al [50] [2011]** observed an unilateral CLF trunk on the right side of a cadaver. The origin of the CLF trunk was 0.79 cm from the CB and 0.33 cm from STA.

**Laxman et al [23] [2014]** reported an unilateral case of high origin of FA. The FA on the left side originated high in the digastric triangle, above the posterior belly of digastric muscle,4.2 cm from CB .

**In the present study,** the mean distance of FA trunk or the CLF trunk from the CB was 1.65 cm. The values varied from 0.1 – 4.7 cm. The distance of FA or the CLF trunk from CB reported in various studies and case reports were within the range observed by the present study.

The surgeons should be aware of the origin of FA to avoid complications during radiologic examinations, exploration of the neck, thyroid and parathyroid surgery, tracheotomy, surgery of the larynx, pharynx, upper oesophagus and parotid gland.

**DISTANCE OF FACIAL ARTERY CROSSING THE MANDIBULAR MARGIN FROM THE ANGLE OF MANDIBLE**.

**Koh et al [22] [2003]** reported that the average distance of FA crossing the MM from MA was 2.72 +/- 0.56 cm in males and 2.68 +/ 0.48 mm in females.

**Magden et al [28] [2004]** found that the FA crossed the mandibular margin at a mean distance of 2.66 cm from the angle of mandible in a cadaveric study.

**A.E.Cicekcibasi et al [7] [2012]** measured the average distance from the MA to the point where FA first appears at the lower margin of mandible using MDCTA . It was 3.53 +/- 0.66 cm and 3.31 +/- 0.73 cm in males on the right and left side respectively. It was 2.91 +/- 0.52 cm and 3.35 +/- 0.48 cm in females on the right and left respectively.

In the **present study**, the average distance of FA crossing the mandibular margin from the MA was 2.95 cm.

The distance measured in the present study coincides with the study done by Magden et al.

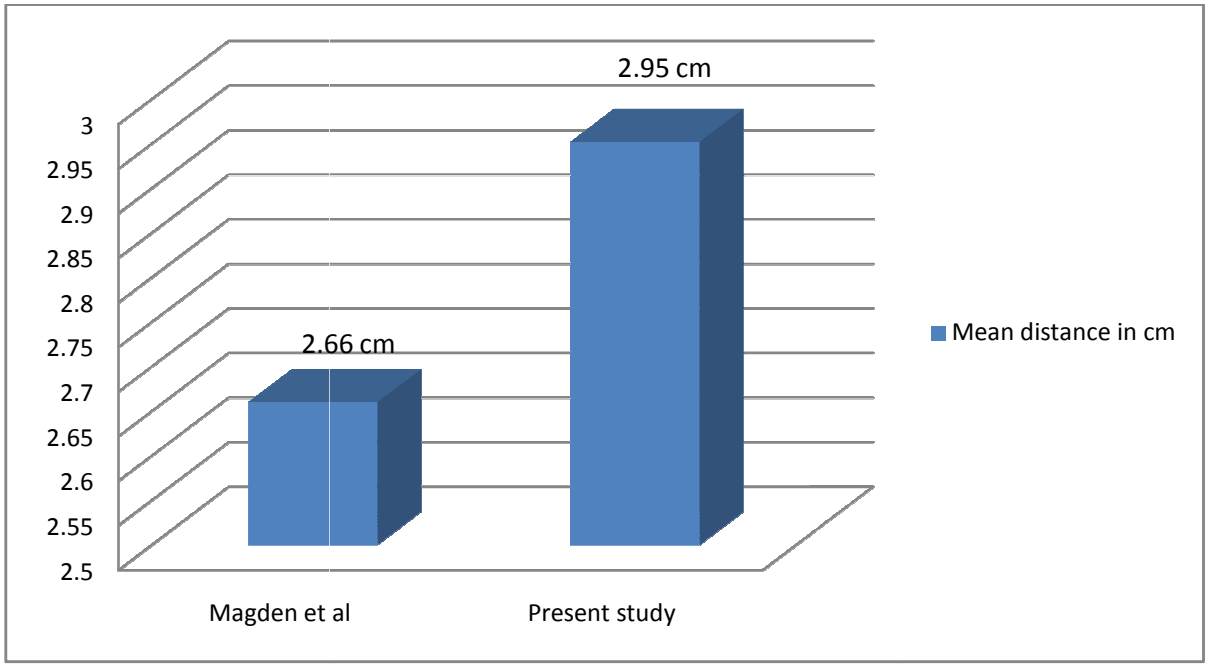
FA is closely related to the marginal mandibular nerve at the mandibular crossing point. Both these structures are at risk during surgeries.

Measurements of FA related to the lower margin of mandible is important to avoid damage to the neurovascular structures during maxillofacial surgeries and anaesthetic dental plastic procedures .

**Table 20 : Mean distance of FA crossing the MM from MA.**

| Studies | Mean distance in cm |
|---|---|
| Magden et al [2004] | 2.66 |
| Present study | 2.95 |

**Chart 9 : Mean distance of FA crossing the MM from MA.**



## BRANCHING PATTERN OF FACIAL ARTERY IN THE FACE

**Nakajima et al [34] [2002]** reported three patterns of FA distribution in the face after their study on 25 FA.

In 22 cases (88%) the FA bifurcated as LNA and SLA at the angle of mouth.

In 2 cases (8%) the FA terminated as AA after branching into SLA and LNA.

In 1 case (4%) the FA continued as AA after branching into SLA. Here the LNA arose from the SLA.

**Loukas et al[25] [2006] :** classified the branching pattern into five types

In Type A, the FA bifurcated into SLA and LNA, where the LNA ended as AA after giving off SAA and IAA.(47.5%).

In Type B, the FA bifurcated into SLA and LNA, but here the LNA ended as SAA. AA was absent ( 38.7 %)

In Type C, the FA terminated as SLA ( 8.4%).

In Type D, the FA terminated as SAA. Here AA arose directly from the FA (3.8 %).

In Type E, the FA terminated as a rudimentary twig without giving any branches (1.4 %)

They also classified the types A- C into various subtype

**S.B.Bayram et al[47] [2010] :** classified the FA branching pattern as

Type I - FA terminating as AA (76%)

Type II - FA terminating as SLA (12 %).

Type III - FA terminating as ILA (12) %.

**George Dickson et al[14] [2013] :** classified the branching pattern of FA into six major types based on the termination of artery.

Type I - FA terminating as SLA

Type II - FA terminating as ILA

Type III - FA terminating as LNA

Type IV - FA terminating as SAA

Type V - FA terminating as IAA

Type VI - FA terminating as AA.

He also mentioned that the termination as SLA and AA (type I and type VI ) were the commonest , 55 % of the total specimens studied.

**L.S.Quadros et al [26] [2013]** classified FA following the classification of Bayram et al. All the specimens on the right side of male cadavers showed type I pattern where the FA terminated as AA. On the left side 78 % had type I and 22 % had type II pattern (here the FA terminated as SLA).Among the 12

female cadavers, on the right side type I was noted in 80 % and type II in 20%.On the left side, type I was observed n 80%,type II in 18 % and type III in 2 % (here FA terminated as ILA)

In the **present study**, the branching pattern of FA in face were classified based on the study done by Loukas et al.

**Type A** was observed in 35 hemifaces (70%) where the FA continued as AA. This is more than type A observed by Loukas et al. This type corresponds to type I of Bayram et al study and type VI of George Dickson study.

**Type B** was observed in 24 % of specimens where FA gave origin to SLA and LNA in succession and AA was absent. This is slightly less than type B observed by Loukas et al. This type was not mentioned by Bayram et al. This corresponds to type III of George Dickson et al study.

**Type C** was observed in 6 % of specimens where FA terminated as SLA. AA and LNA were absent. This corresponds to type C of Loukas et al. This corresponds with type II of Bayram et al and type III of George Dickson.

**Type D and Type E** were not observed in the present study.

The incidence of type A coincides with Bayram et al study. The incidence of type B and type C coincides with Loukas et al study. The difference in the incidence observed is due to wide variation in the branching pattern of FA.

By classifying the various patterns of FA in the face, the surgeons have a better understanding of the arterial distribution of the face. This knowledge increases the confidence of plastic surgeons during reconstructive procedures.

**Presence of unusual branches of facial artery in the face**

**Zhao et al [53] [2002] :** detected the presence of FA branches in the buccinator region by doppler method in 92.4 % of cases.

**Magden et al[39] [2009]** found that in 3 % cases the diameter of premasseteric branch was larger than the FA.

**Ariji et al [4] [2010]** studied the blood supply of the masseter muscle. In 21.1 % the muscle was supplied by the FA.

**Kumar et al[35] [2011] :** observed an unusual posterior branch of facial artery (premasseteric branch).

**Lydia S.Quadros et al[26] [2013]** noted prominent and large premasseteric branch in 4 hemifaces during their study of 50 hemifaces.

**In the present study**

Premasseteric branch was present in 14 hemifaces (28 %).7 PMA belonged to type A, 4 PMA belonged to type B, 4 PMA belonged to type C.

Buccal branch was present in 6 hemifaces (12%). 2 BA belonged to type A, 4 BA belonged to type B.

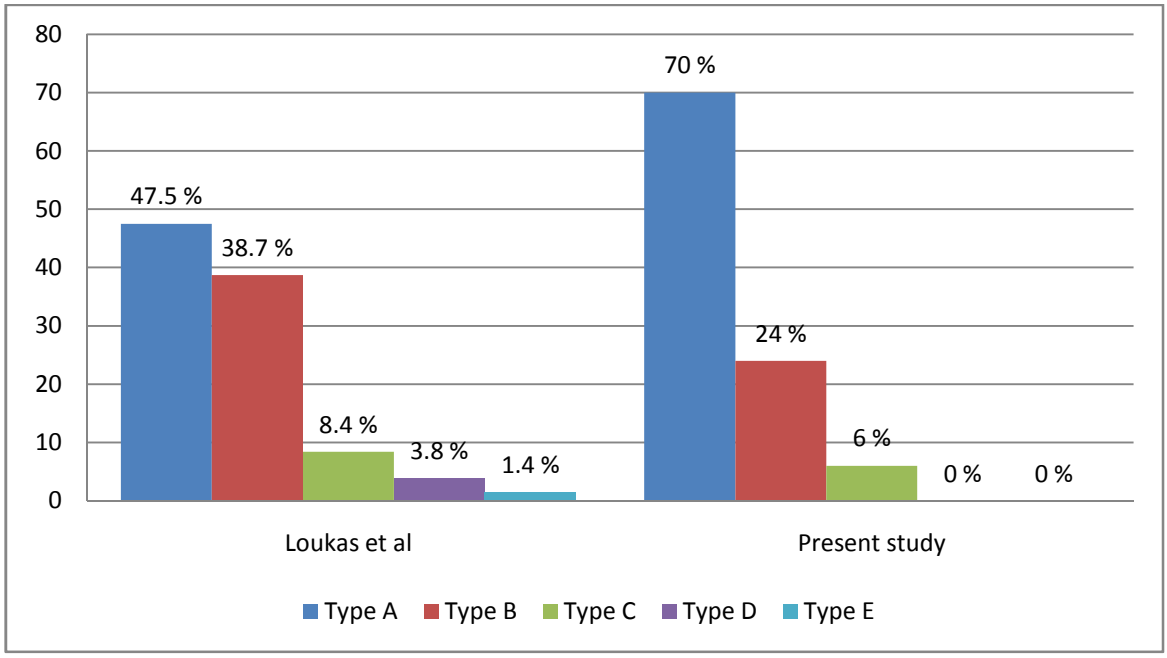
Premasseteric branch of the FA supplies the masseter muscle. The masseter muscle flap is useful in transposition operations to correct facial palsy and in upper and lower lip reconstruction. Knowledge of the blood supply of masseter is important to prevent fatal haemorrhage during maxillofacial surgeries. This artery can compress the facial vein or parotid duct while crossing them. Thus plastic surgeons, radiologists, craniofacial surgeons should be aware of such unusual branch in the face.

Buccinator muscle mucosal flap is used for the treatment of mucosal defects after tumour resection, osteomyelitis of the mandible, closure of cleft palate fistulas, primary closure of very wide cleft palate, and lengthening of the soft palate.

## Table 21 : Branching pattern of FA in face

| Branching pattern | Loukas et al [2006] | Present study |
|---|---|---|
| **A** | 47.5% | 70% |
| **B** | 38.7% | 24% |
| **C** | 8.4% | 6% |
| **D** | 3.8% | Nil |
| **E** | 1.4% | Nil |

## Chart 10: Branching pattern of FA in face



## SYMMETRY IN THE BRANCHING PATTERN OF FACIAL ARTERY.

**Niranjan et al[37] [1988]** noted bilateral symmetrical branching pattern in 68 % of cases .

**Koh et al[22] [2003]** observed bilateral symmetry in 54.5 % of cases.

**Pinar et al[40] [2005]** found symmetrical branching pattern on both sides in 68 % cases.

In the **present study** 52% of cadavers showed bilateral symmetry.

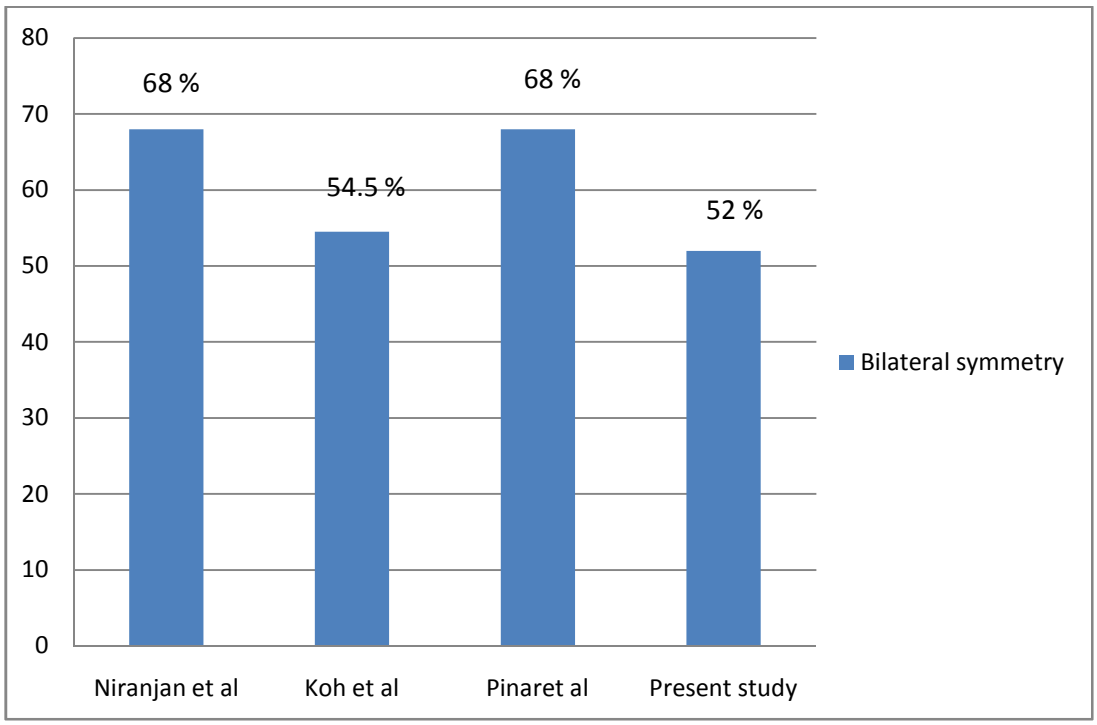
The results of the present study coincides with Koh et al. The percentage of bilateral symmetry is slightly more in the other two studies. But in all the above mentioned studies the percentage of bilateral symmetry of FA branching pattern is more than unsymmetrical branching pattern.

The knowledge of the unsymmetrical branching pattern is important in radiological procedures to correctly interpret the vasculature of face.

**Table 22: Symmetry in the branching pattern of FA.**

| Studies | Bilateral symmetry |
|---|---|
| Niranjan et al [1988] | 68 % |
| Koh et al [2003] | 54.5% |
| Pinar et al [2005] | 68 % |
| Present study | 52 % |

**Chart 11 : Symmetry in the branching pattern of FA.**



## MODE OF TERMINATION OF FACIAL ARTERY

**Niranjan et al[37] [1988]** reported 4 modes of termination as follows FA terminated as AA in 68%, FA terminated as LNA in 26 % , FA terminated as SLA in 4% and FA terminated at the alar base in 2 %.

**Pinar et al[40] [2005]** described 5 modes of termination of FA .60 % of FA ended as a nasal vessel, 22% of FA ended as an angular vessel,12 % FA ended as an alar vessel , 4% FA ended as a superior labial vessel. 2 % FA was hypoplastic.

**Loukas et al[25] [2006]** found that FA in 51.4 % of specimens terminated as AA, 38.73 % of FA terminated as LNA, 8.45 % of FA terminated as SLA.1.4 % of FA terminated as hypoplastic artery.

**Bayram et al[47] [2010]** reported that 76 % FA terminated as AA. 12 % FA terminated as SLA, and 12 % FA terminated as ILA.

**Jiang et al [20] [2008]** evaluated the FA using CT angiography. Left FA in 26.67 % ended below the angle of the mouth ,in 15.56 % terminated between the angle of the mouth and the nasal wing in, and in 57.77 % terminated above the nasal . The right FA in 15.56 % ended below the angle of the mouth , in 26.67 % terminated between the angle of the mouth and the nasal wing, and in 57.77 % terminated above the nasal wing .

**Furukuwa et al [12] [2013]** studied 187 FA using the CT angiography .They noted 4 types of termination of FA. In type 1, FA ended proximal to the SLA; In type 2, it ended distal to the SLA, In type 3,it terminated as AA; and in type 4, FA had duplex with dominant lateral angular branch. 34 % of cases belonged to type 1. 40% of cases belonged to type 2 .24% belonged to type 3 and 2 % belonged to type 4.

## Termination as hypoplastic / rudimentary facial artery.

**Henry Hollinshed[16] [1961]** has quoted about the occurrence of hypoplastic artery which extended only upto the angle of mouth.

**Pinar Y.A et al[40] [2005]** reported 2 % cases where FA were hypoplastic.

**Loukas et al[25] [2006]** in his classification of branching pattern of FA in face had mentioned type E as rudimentary FA (1.4%)

**Lohn et al[24] [2011]** reported 5 rudimentary FA out of 201 FA .

In the **present study**, 4 modes of termination was observed as follows

The FA terminated as AA in 70% cases, terminated as LNA in 24% cases, terminated as SLA in 4% cases and terminated as IAA in 2 % cases. No rudimentary artery was observed in the present study.

In all the above studies FA terminating as AA was the most common , followed by LNA , SLA and IAA in that order except Pinar et al where the most common is the termination as LNA ,followed by AA and then alar artery.

.

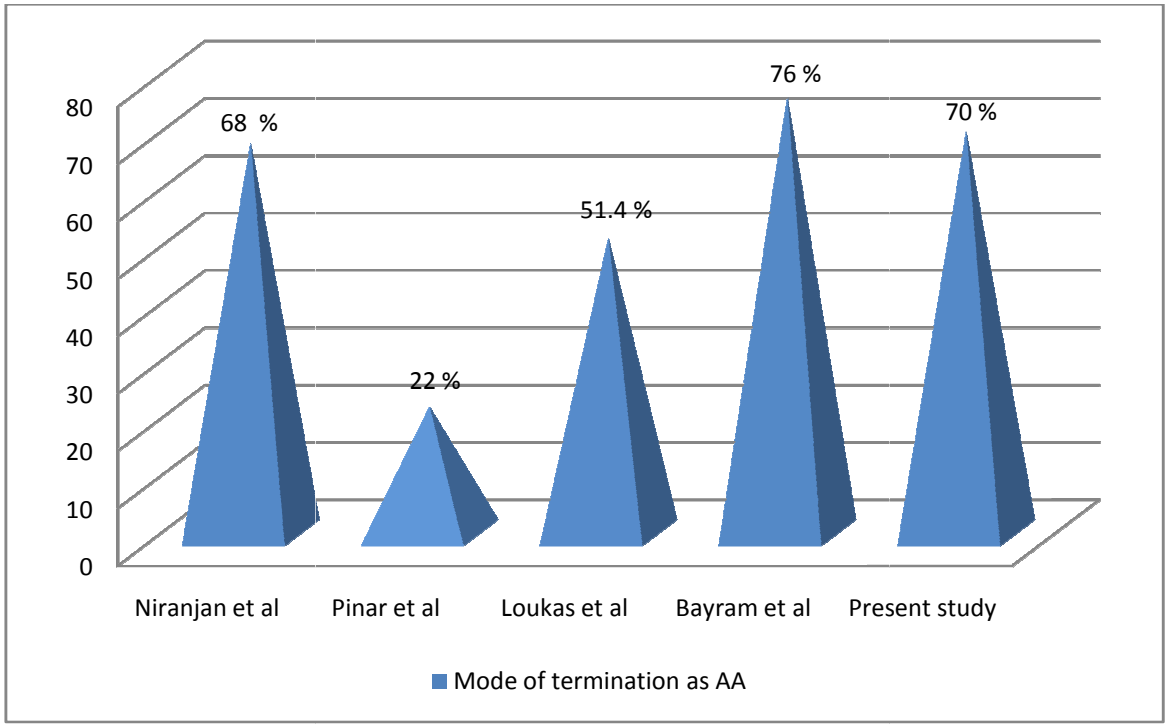
Other modes of termination were not observed in the present study.

The choice of the flap for reconstructive surgery depends on the mode of termination of FA in the face. Recently developed facial artery musculo mucosal flap (FAMM) has gained importance due to its many advantages. When the FA terminates at the angle of mouth, the surgical planning of FAMM flap should be limited. At least one FA should be patent for raising a successful flap. So in case of bilateral hypoplastic FA , the surgeon has difficulty in raising a viable flap.

## Table 23 : Mode of termination as AA

| Studies | Percentage |
|---|---|
| Niranjan et al [1988] | 68 % |
| Pinar et al [2005] | 22 % |
| Loukas et al [2006] | 51.4% |
| Bayram et al [2010] | 76 % |
| Present study | 70 % |

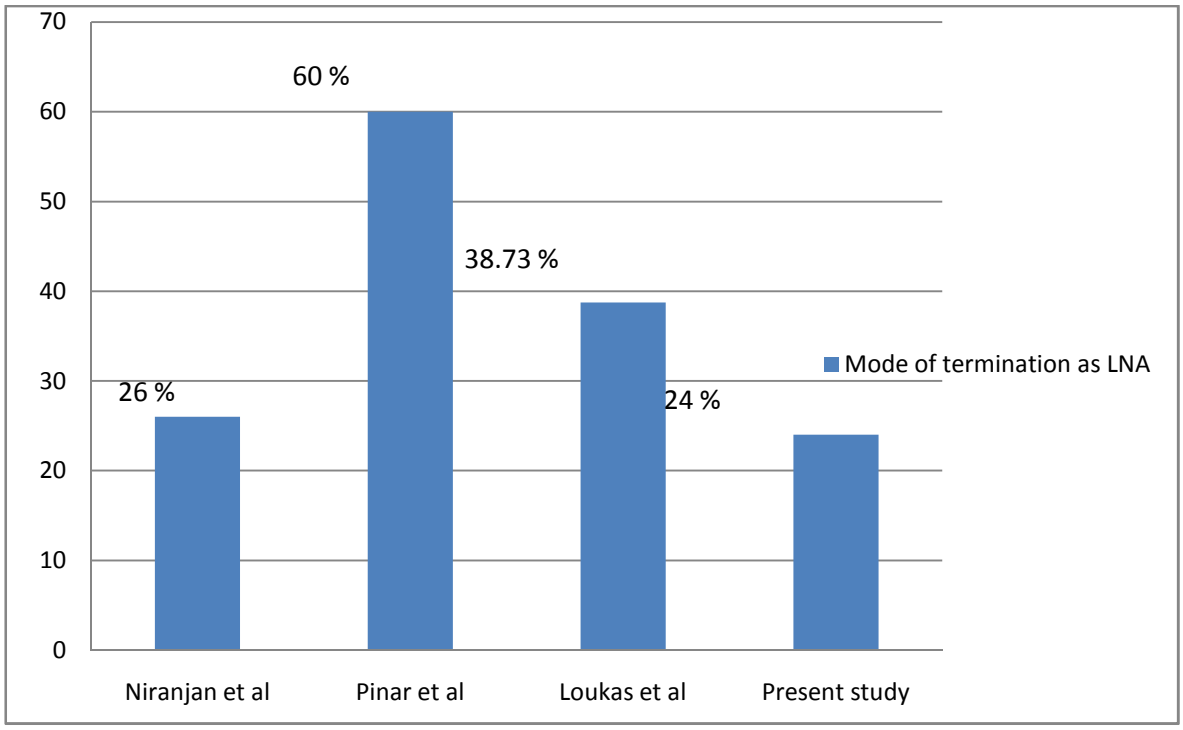
## Chart 12 : Mode of termination as AA



## Table 24 : Mode of termination as LNA

| Studies | Percentage |
|---|---|
| Niranjan et al [1988] | 26 % |
| Pinar et al [2005] | 60% |
| Loukas et al [2006] | 38.73 % |
| Present study | 24% |

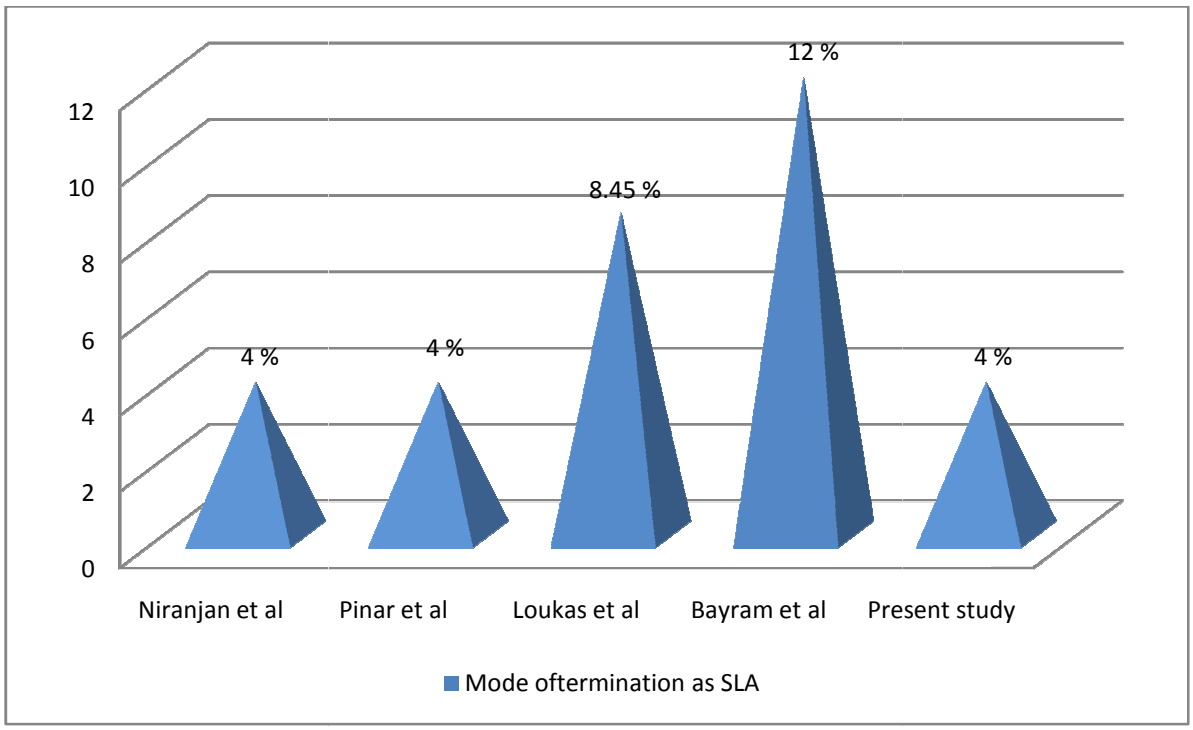
## Chart 13 : Mode of termination as LNA



## Table 25 : Mode of termination as SLA

| Studies | Percentage |
|---|---|
| Niranjan et al [1988] | 4 % |
| Pinar et al [2005] | 4 % |
| Loukas et al [2006] | 8.45 % |
| Bayram et al [2010] | 12 % |
| Present study | 4 % |

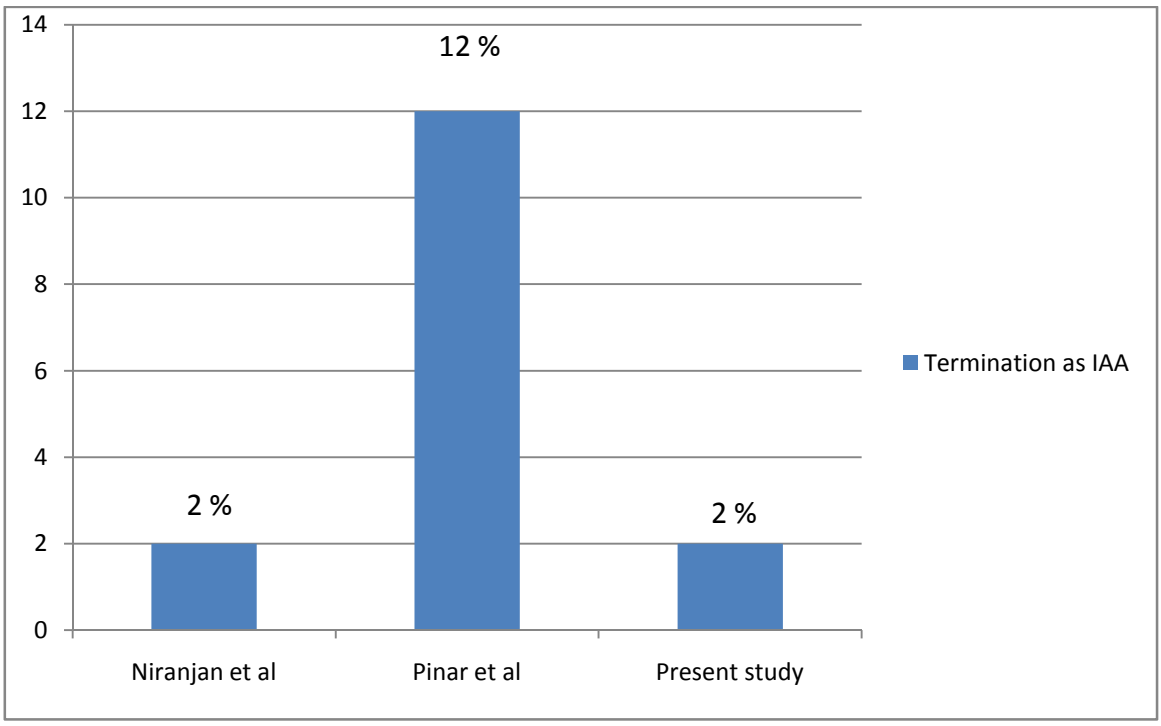
## Chart 14 : Mode of termination as SLA



## Table 26 : Mode of termination as IAA

| Studies | Percentage |
|---|---|
| Niranjan et al [1988] | 2 % |
| Pinar et al [2005] | 12 % |
| Present study | 2% |

## Chart 15: Mode of termination as IAA



## SUBMENTAL ARTERY

### LENGTH OF SUBMENTAL ARTERY

### DISTANCE OF ORIGIN OF SUBMENTAL ARTERY FROM THE ORIGIN OF FACIAL ARTERY

### DISTANCE OF ORIGIN OF SUBMENTAL ARTERY FROM THE ANGLE OF MANDIBLE.

**Magden et al[28] [2004]** : found that the mean length of SMA was 5.89 cm. The mean distance between the origin of SMA and the origin of FA was 2.75 cm. The mean distance of SMA from the MA was 2.38 cm.

**In the present study in** all the specimen the SMA arose from the FA separately. The average length was 7.44 cm. The mean distance of origin of SMA from the origin of FA was 3.36 cm. The average distance of origin of SMA from MA was 2.88 cm.

The origin , location and length of the SMA in the present study coincides with the study done by Magden et al.

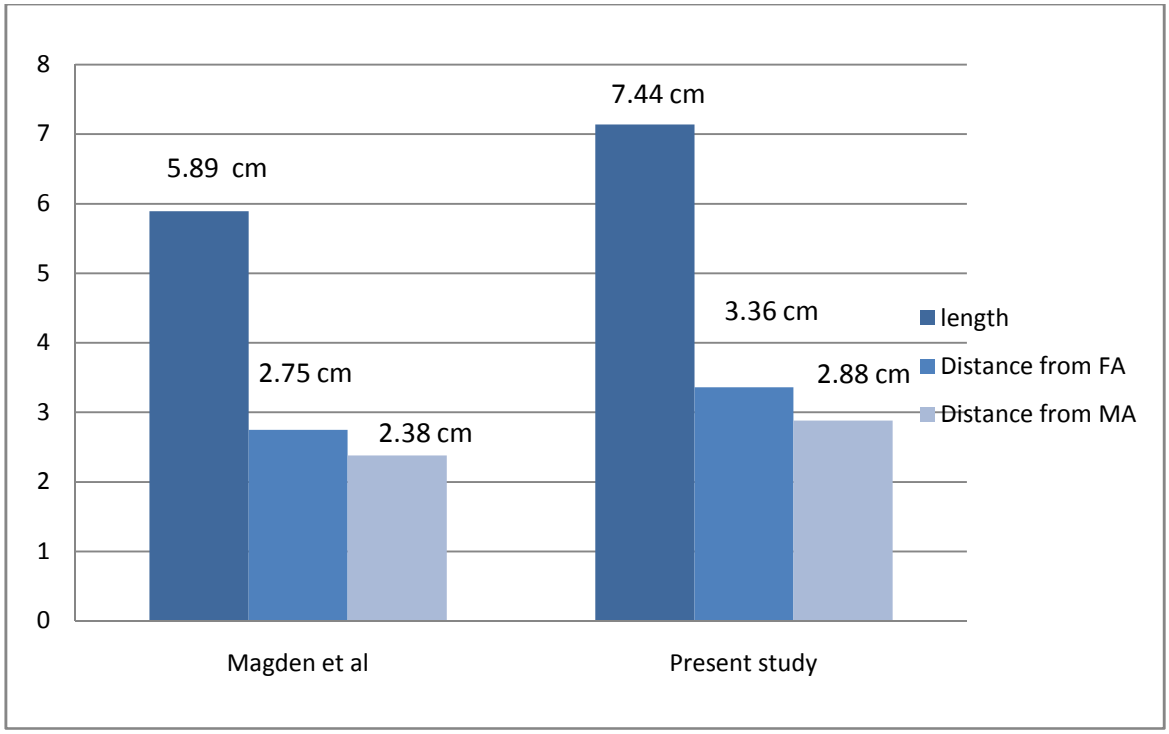
The Submental artery flap is an excellent option in head and neck reconstruction procedures. Its advantages are good colour match and a relatively acceptable donor site. Submental artery island flap surpasses the other flaps in reconstruction of the mustache and beard in male patients.

Difficulty in the reconstruction of maxillary defects that includes alveolar processes and hard palate is solved by devising submental artery island flap.

**Table 27 : Study on SMA**

| **Parameters** | Magden et al [2004] | Present study |
|---|---|---|
| **Length** | 5.89 cm | 7.44 cm |
| **Distance from origin of FA** | 2.75 cm | 3.36 cm |
| **Distance from MA** | 2.38 cm | 2.88 cm |

**Chart 16 : Study on SMA**



## INFRA LABIAL ARTERY

### INCIDENCE OF INFRA LABIAL ARTERY

**George A Piersol[14] [1930] ,J.Parsons Schaffer[19] [1952] ,Wood Jones[10] [1953] ,Henry Hollinshed[16] [1961],Russell T.Woodburne[44] [1961]** have said that two ILA can occur and they have named the second artery as infra labial artery or sub labial artery.

**Edizer et al[8] [2003]** found that in 71 % cases sub labial arteries were present.

In the **present study** infra labial artery was present in 58 % of specimens.

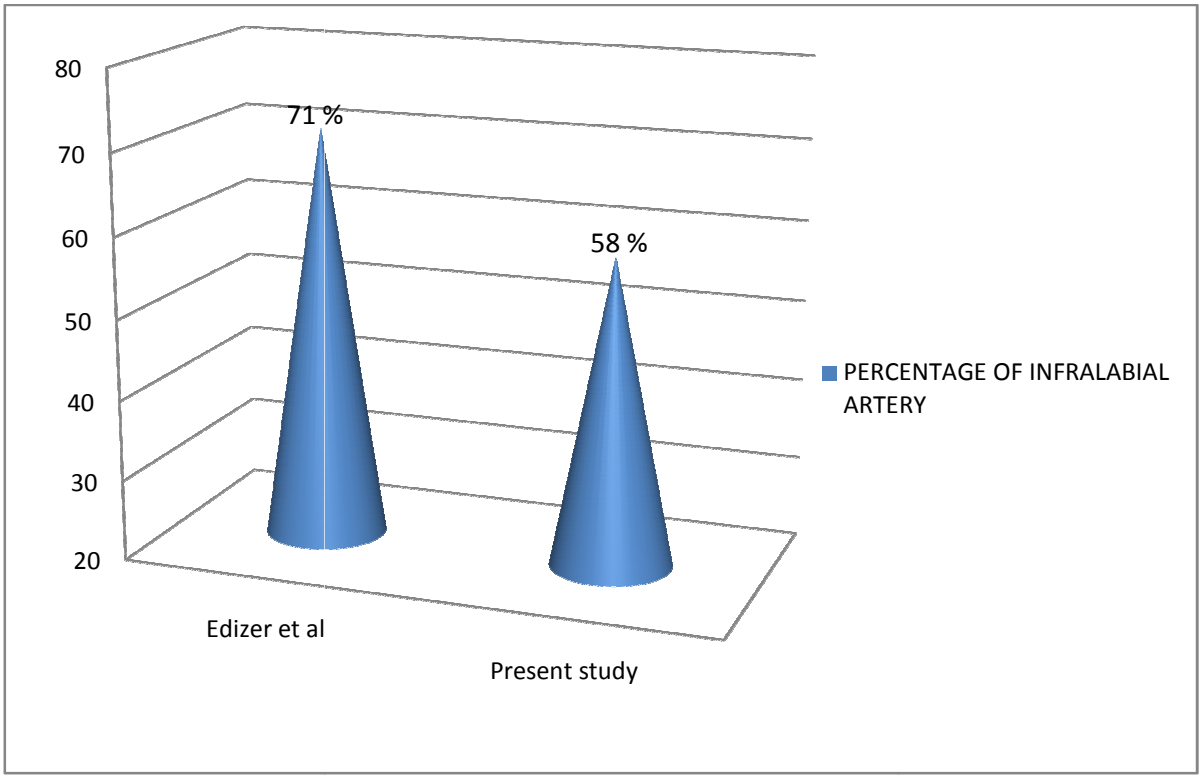
In the study done by Edizer et al and the present study, more than half the specimen had 2 ILA.

The knowledge of the variation in the branching pattern and distribution of labial arteries is essential in maxillofacial surgeries.` The knowledge of the distribution of perioral arterial branches is useful for surgeons to devise new flaps for surgery around the mouth.

## Table 28 : Incidence of InfraLabial Artery

| Studies | Percentage |
|---|---|
| Edizer et al [2003] | 71 % |
| Present study | 58 % |

## Chart 17: Incidence of InfraLabial Artery



## LENGTH OF INFRALABIAL ARTERY

**Edizer et al[8] [2003]** studied the blood supply of the lower lip and reported that the average length of sublabial artery as 2.34 cm .

In the **present study** the mean length of infralabial artery was 2.48 cm.

## DISTANCE OF ORIGIN OF INFRALABIAL ARTERY FROM THE ORAL COMMISSURE.

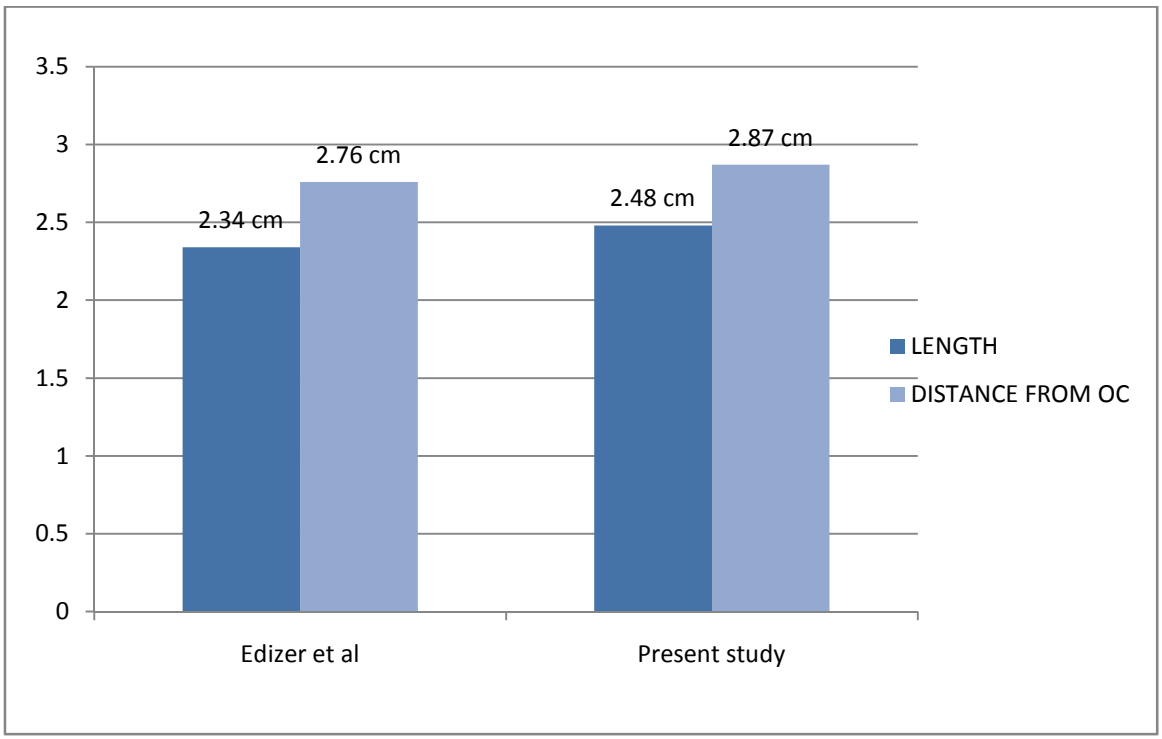
**Edizer et al[8] [2003]** measured the mean distance between the origin of ILA from the angle of mouth as 2.76 cm. They reported that the infra labial artery originated from the FA or ILA.

In the **present study,** all the infra labial arteries originated from the FA**.** The mean distance between the origin of infralabial artery and the OC was 2.87 cm.

## Table 29 : Study on infra labial artery

| Parameters | Edizer et al [2003] | Present study |
|---|---|---|
| **Length** | 2.34 cm | 2.48 cm |
| **Distance from OC** | 2.76 cm | 2.87 cm |

## Chart 18 : Study on infra labial artery



## INFERIOR LABIAL ARTERY

### ORIGIN OF INFERIOR LABIAL ARTERY IN RELATION TO THE ORAL COMMISSURE

**Pinar et al[40] [2005]** found that ILA was above the angle of mouth in 8% specimens. ILA was below the angle of mouth in 22%. In 30 specimens ILA was at the angle of mouth (60%). In 10 % specimens ILA was absent.

In the **present study** , in 24% of cases, ILA was located at the level of OC, in 72 % of cases, ILA was located below the OC. In 4 % cases ILA was absent. No ILA was found above the OC.

**Table 30 : Origin of ILA in relation to the OC**

| **Level of ILA** | Pinar et al [2005] | Present study |
|---|---|---|
| **Above the OC** | 8 % | Nil |
| **At the OC** | 60 % | 24 % |
| **Below the OC** | 22 % | 72 % |
| **Absent ILA** | 10 % | 4 % |

**DISTANCE OF ORIGIN OF INFERIOR LABIAL ARTERY FROM THE ORAL COMMISSURE.**

**Edizer et al[8] [2003]** The average distance between the origin of ILA from the OC was 2.39 cm.

**Aravena et al[3] [2008]** reported that the average distance of origin of ILA from OC as 3.05 cm.

**Al Hogail et al [1] [2008]** reported that the ILA arose below the labial commissure in 42.9% and with SLA as a common stem in 28.6 %.

**Douglas L. Schulte[45] [2009]** reported that ILA was found within 1.5 cm from the lower lip.

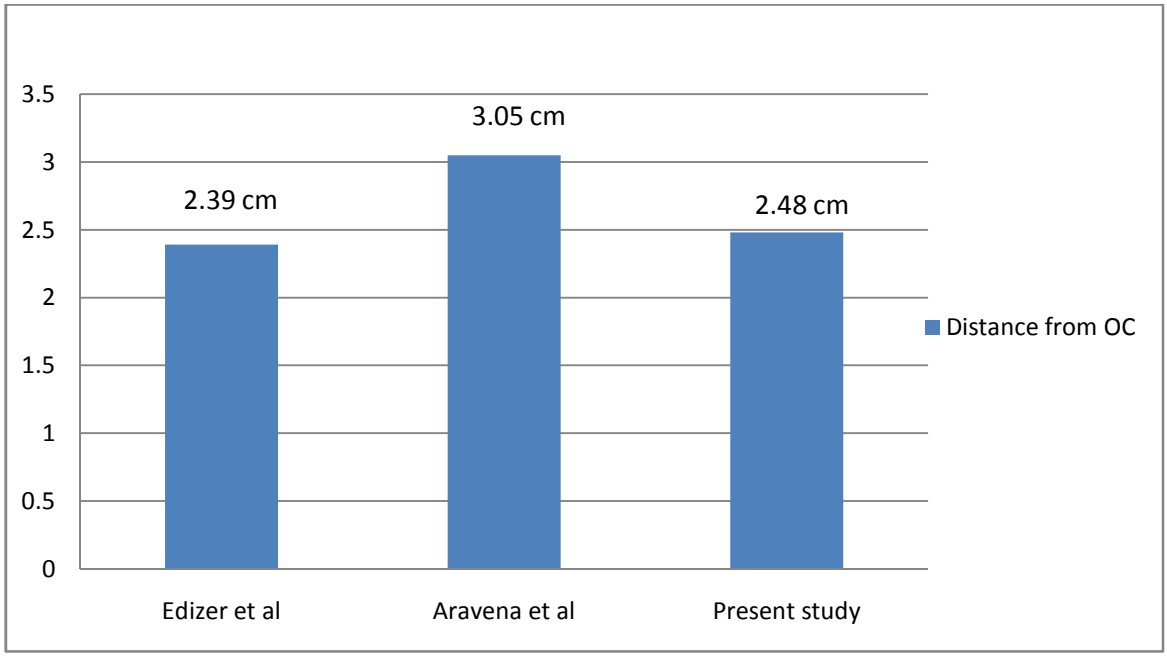
In the **present study** the average distance of ILA origin from OC was 2.48 cm.

ILA flap is an ideal choice for one-stage reconstruction of full-thickness upper lip defect. Vermilion lower lip cross flap is used for reconstruction of upper lip in cases of trauma or cleft lip. Flap survival depends on incorporation of inferior labial artery in the pedicle. The surgeons should be aware of the incidence of absent ILA in raising such flaps.

**Table 31 : Distance of the origin of ILA from OC.**

| Studies | Distance in cm |
|---|---|
| Edizer et al [2003] | 2.39 |
| Aravena et al [2008] | 3.05 |
| Present study | 2.48 |

**Chart 19 : Distance of the origin of ILA from OC.**



## LENGTH OF INFERIOR LABIAL ARTERY.

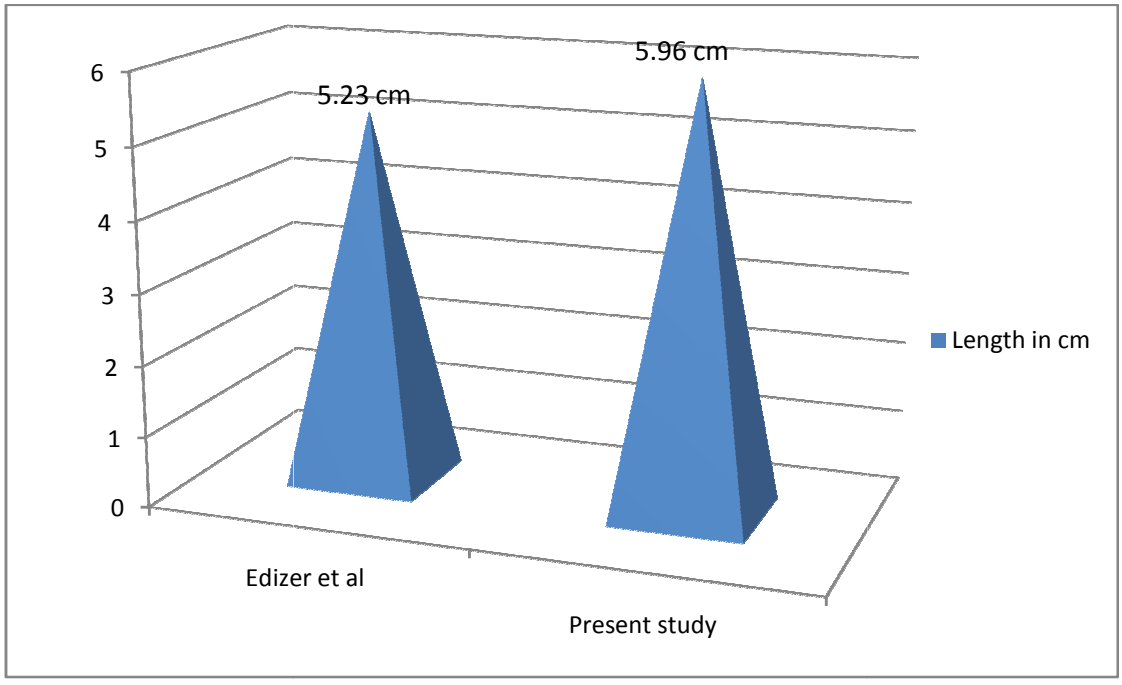
**Edizer et al[8] [2003]** The mean length of ILA was 5.23 cm.

In the **present study** the mean length of ILA was 5.96 cm.

**Table 32 : Length of ILA**

| Studies | Length in cm |
|---|---|
| Edizer et al [2003] | 5.23 |
| Present study | 5.96 |

**Chart 20 : Length of ILA**



## SUPERIOR LABIAL ARTERY

## ORIGIN OF SUPERIOR LABIAL ARTERY IN RELATION TO THE ORAL COMMISSURE

**Pinar et al[40] [2005]** in 72.3% specimens, the SLA was above the angle of mouth. In 27.7% the SLA was at the angle of mouth.

**Aravena et al[3] [2008]** observed that in all the samples SLA originated above the oral commissure.

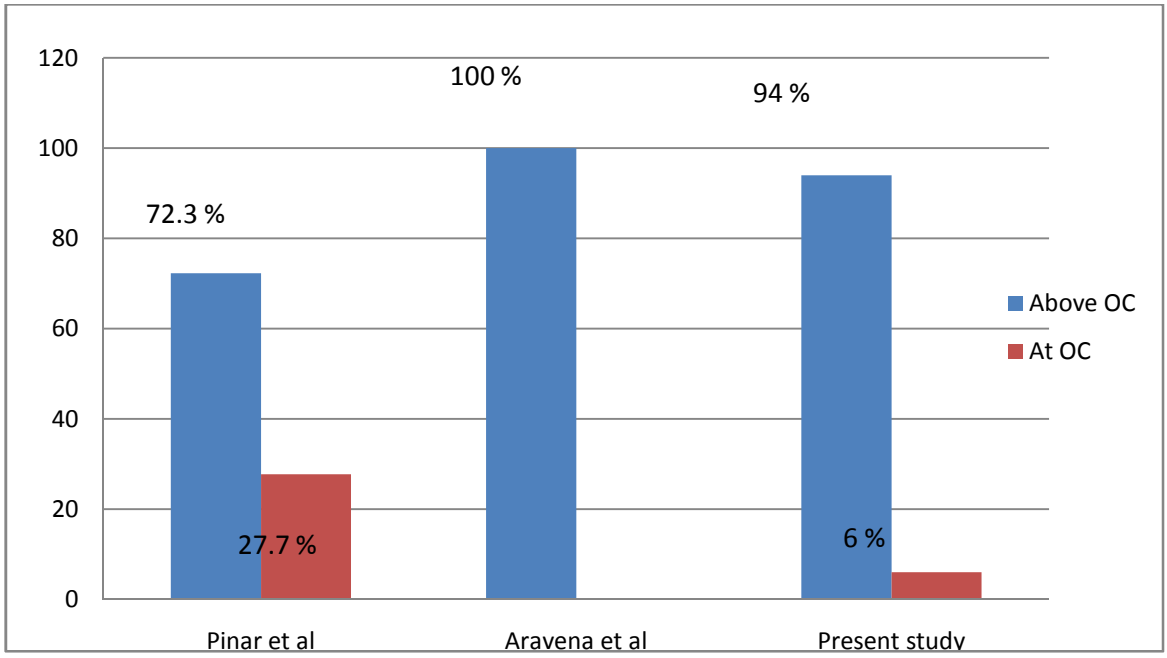
**Al-hoqail et al [1][2008]** reported that the SLA arose above the labial commissure in 78.6 %. Septal and subalar branches also contributed to it. Septal branches were present in all specimens. Subalar branch was absent in a single specimen.

**In the present study,** 94 % of SLA arose above the level of OC ,6 % at the level of OC .

## Table 33 : Origin of SLA in relation to the OC

| Origin of SLA | Pinar et al [2005] | Aravena et al [2008] | Present study |
|---|---|---|---|
| **Above OC** | 72.3 % | 100 % | 94% |
| **At the level of OC** | 27.7% | NIL | 6% |

## Chart 21 : Origin of SLA in relation to the OC



**DISTANCE OF ORIGIN OF SUPERIOR LABILA ARTERY FROM THE ORAL COMMISSURE.**

**Magden et al[28] [2004]** reported that the mean distance between the origin of SLA from the OC was 1.21 cm.

**Aravena et al[3] [2008]** measured the average distance of SLA origin from OC as 1.17 cm

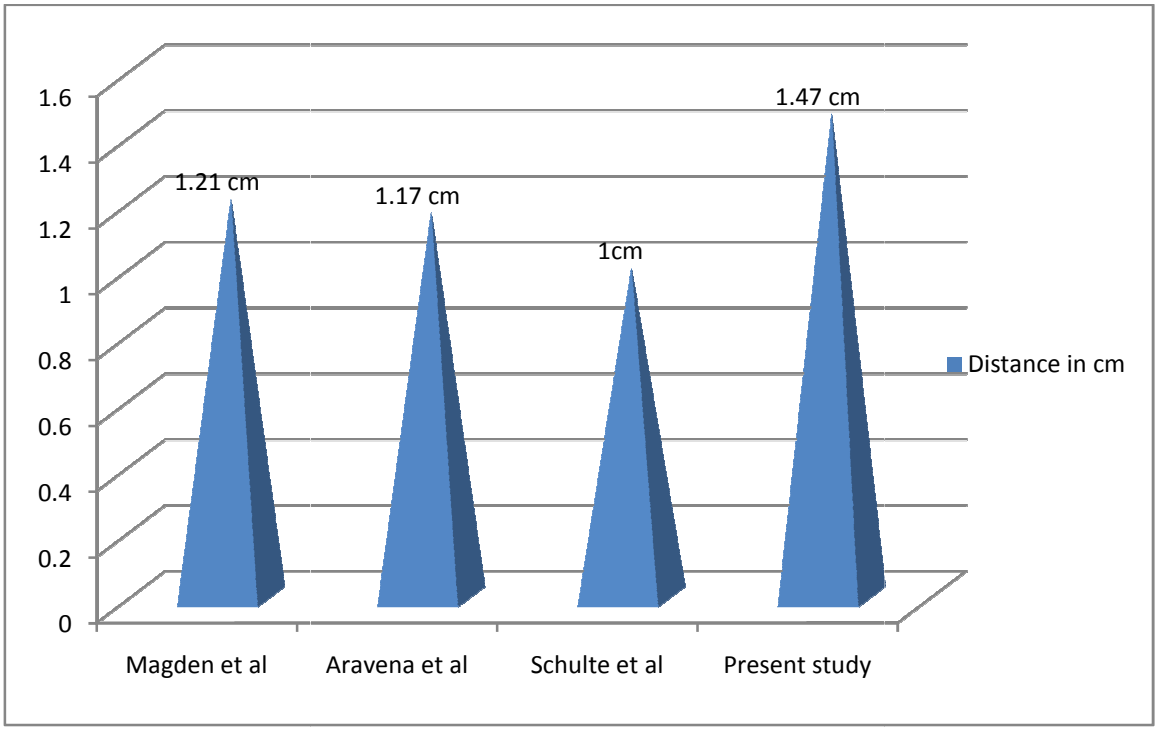
**Schulte et al [45] [2009]** reported that the SLA was found within 1.0 cm of the free margin of the upper lip.

**In the present study the** average distance of SLA origin from OC was 1.47 cm

**Table 34 : Distance of origin of SLA from the OC.**

| Studies | Distance in cm |
|---|---|
| Magden et al [2004] | 1.21 |
| Aravena et al [2008] | 1.17 |
| Schulte et al [2009] | 1 |
| Present study | 1.47 |

**Chart 22 : Distance of origin of SLA origin from the OC.**



## LENGTH OF SUPERIOR LABIAL ARTERY.

**Ran et al[42] [1998]** found that the average length of SLA was 9 cm.

**Magden et al[27] [2004]** found that the mean length of SLA was 4.54 cm (2.9-8.5 cm).

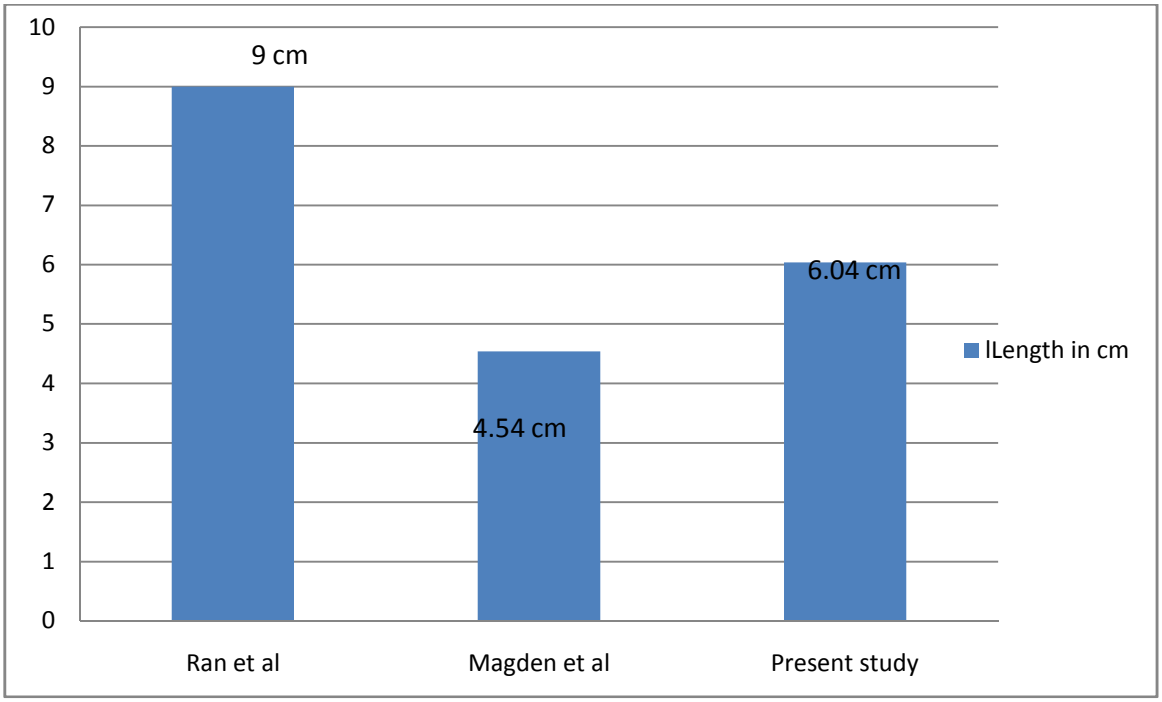
**In the present study** the mean length of SLA was measured as 6.04 cm.

Parameters related to the perioral branches are useful in devising new flaps to reconstruct lip defects. Abbe flap, Eslander flap and Goldstein flap involves rotation around its vascular pedicle, which consists of SLA. Detailed knowledge of anatomy of SLA is necessary in creating a successful flap. Inadvertent ligation of SLA can create a non viable flap.

## Table 35 : Length of SLA

| Studies | Mean length in cm |
|---|---|
| Ran et al [1998] | 9 |
| Magden et al [2004] | 4.54 |
| Present study | 6.04 |

## Chart 23 : Length of SLA



# *Conclusion*

# CONCLUSION

The facial artery was studied with respect to its origin, location, branching pattern and mode of termination in 50 hemifaces. Its submental and perioral branches were studied in detail.

The results were noted and compared to that of previous studies. The following are the conclusions derived from the present study:

FA arose separately from the ECA in 82 % of specimens and 93.33 % of angiograms. CLF trunk was present in 18 % of specimens and 6.66 % of angiograms. The CLF trunk was present bilaterally in 12% of cadavers.

The average distance of FA trunk or the CLF trunk from the carotid bifurcation was 1.65 cm.

The average distance of FA crossing the mandibular margin from the MA was 2.95 cm.

The branching pattern of FA in face was classified based on the study done by Loukas et al. 70 % of specimens belonged to type A pattern, 24 % of specimens belonged to type B pattern and 6 % of specimens belonged to type C pattern.

Some unusual branches were noted in the face. In 28 % of specimens, premasseteric branch was present. In 12 % of specimens, buccal branch was present.

In 52 % of cadavers the branching pattern and mode of termination of FA were symmetrical on both sides

The FA in 70% specimens, terminated as AA. In 24% specimens, it terminated as LNA. In 4% of specimens, it terminated as SLA and in 2 % of specimens, it terminated as IAA.

The submental artery was present singly in all cases. Its average length was 7.44 cm. The mean distance of origin of SMA from the origin of FA was 3.36 cm. The mean distance of origin of SMA from the MA was 2.88cm.

Infra labial artery was present in 58% of cadaveric specimens and 53.33 % of angiograms. The average length of Infra labial artery was 2.48 cm. The mean distance of origin of Infra labial artery from the OC was 2.87 cm.

In 24 % of specimens, ILA arose from FA at the level of OC. In 72 % of specimens, ILA arose from FA below the level of OC. In 4 % of specimens, ILA was absent. The mean distance of origin of ILA from the OC was 2.48 cm. The mean length of ILA was 5.96 cm.

In 94% of specimens, SLA arose from FA above the level of OC and in 6% of specimens, it arose at the level of OC. The average distance of SLA from the OC was 1.47 cm. The mean length of SLA was 6.04 cm.

This additional information on FA anatomy will be useful for plastic surgeons for better planning of reconstructive procedures, raising viable flaps and devising new flaps. Prior knowledge of the variation in the origin and branching pattern of FA helps the radiologists in better interpretation of radiological images .It also helps in avoiding complications during surgeries in the submandibular and facial region.

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# MASTER CHART

| S.NO | MODE OF ORIGIN | LEVEL | FA -MA | BRANCHINGPATTERN | UNUSUAL BRANCHES | SYMMETRY | TERMINATION | SMA LENGTH | FA-SMA | SMA-MA | PRESENCE OF INFRA LABIA ARTERY | INFRALABIAL-LENGTH | INFRALABIAL-OC | ILA LENGTH | RELATION TO OC | ILA-OC | SLA-LENGTH | RELATION TO OC | SLA-OC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | S | 1.2 | 3.1 | A | Nil | S | AA | 7.6 | 3.4 | 3.2 | A | NA | NA | 5.5 | B | 3.4 | 6 | A | 1.7 |
| 2 | S | 1.3 | 3 | A | Nil | S | AA | 7.2 | 3.6 | 3.3 | A | NA | NA | 5.6 | B | 3.5 | 6.3 | A | 1.8 |
| 3 | CLF | 2.1 | 2.8 | B | Nil | US | LNA | 7 | 3.2 | 3.3 | P | 2.7 | 3.1 | 6.8 | B | 3 | 7.1 | A | 1.5 |
| 4 | CLF | 2 | 2.9 | A | Nil | US | AA | 7 | 3.1 | 3.4 | P | 2.9 | 3.2 | 6.9 | B | 3.1 | 7.2 | A | 1.6 |
| 5 | S | 1.5 | 3.2 | A | PM | US | AA | 8.4 | 3.4 | 2.9 | A | NA | NA | 6.3 | B | 3.2 | 6.9 | A | 1.8 |
| 6 | S | 1.6 | 3 | B | PM | US | LNA | 8.6 | 3.5 | 2.8 | A | NA | NA | 6.4 | C | 2.5 | 6.8 | A | 1.9 |
| 7 | S | 1.8 | 3.2 | A | Nil | S | AA | 8.7 | 3.6 | 3.1 | P | 2.3 | 3 | 6.7 | B | 3.5 | 6.5 | C | 0.8 |
| 8 | S | 1.6 | 3.3 | A | Nil | S | AA | 8.2 | 3.6 | 3 | P | 2.2 | 3.1 | 6.6 | B | 3.1 | 6.6 | C | 0.9 |
| 9 | S | 1.6 | 2.7 | C | PM | S | SLA | 7.1 | 3 | 2.8 | P | 2 | 3 | 7.6 | C | 2.3 | 8 | A | 2.1 |
| 10 | S | 1.4 | 2.9 | C | PM | S | SLA | 7 | 3.4 | 2.7 | P | 2.2 | 2.9 | 7.8 | C | 2.5 | 8.3 | A | 2.2 |
| 11 | CLF | 0.1 | 3.3 | A | Nil | US | AA | 6.2 | 3.3 | 3.1 | P | 2.3 | 3.2 | 6 | B | 2.2 | 5.3 | A | 0.9 |
| 12 | CLF | 1 | 3.2 | B | B | US | LNA | 6.3 | 3.2 | 3.1 | P | 2.3 | 3.1 | 6.1 | B | 2.4 | 5.2 | A | 1 |
| 13 | S | 1.3 | 2.8 | A | PM | S | AA | 7.2 | 3.1 | 2.8 | A | NA | NA | NA | NA | 0 | 7.1 | A | 1.2 |
| 14 | S | 1.3 | 2.9 | A | PM | S | AA | 7.3 | 3.1 | 2.8 | A | NA | NA | NA | NA | 0 | 7.2 | A | 1.3 |
| 15 | S | 1.9 | 3.4 | B | Nil | US | LNA | 5.5 | 3.9 | 2.6 | A | NA | NA | 4.2 | C | 2.4 | 4 | A | 1.5 |
| 16 | S | 2.1 | 2.7 | C | PM | US | IAA | 5.6 | 3.8 | 2.7 | A | NA | NA | 4.4 | C | 2.3 | 4.2 | A | 1.6 |
| 17 | S | 2.2 | 2.9 | A | Nil | S | AA | 8.8 | 3.7 | 3.1 | P | 2.1 | 2.9 | 7.4 | B | 4 | 6.3 | A | 0.9 |
| 18 | S | 2 | 3.1 | A | Nil | S | AA | 8.6 | 3.8 | 3.2 | P | 2.5 | 2.1 | 7 | B | 4.2 | 6.2 | A | 0.8 |
| 19 | S | 1.9 | 3 | A | Nil | S | AA | 9 | 3.2 | 3 | P | 3.2 | 3.2 | 4.4 | B | 3.6 | 4.5 | A | 1.5 |
| 20 | CLF | 0.5 | 3.2 | A | Nil | S | AA | 8.8 | 3 | 3 | P | 2.9 | 3.1 | 4.6 | B | 3.5 | 4.6 | C | 0.6 |
| 21 | S | 1 | 3.3 | A | PM | S | AA | 7.2 | 3.1 | 2.8 | P | 2.9 | 3.2 | 6.9 | B | 1.5 | 5.2 | A | 2.1 |
| 22 | S | 1.1 | 2.8 | A | PM | S | AA | 7.6 | 3.2 | 2.6 | P | 2.7 | 3.1 | 6.8 | B | 3.3 | 5.3 | A | 2.2 |
| 23 | S | 1.6 | 2.6 | B | B | US | LNA | 6.8 | 3.4 | 2.5 | A | NA | NA | 7.6 | B | 1.1 | 7.1 | A | 0.8 |
| 24 | S | 1.6 | 2.9 | A | B | US | AA | 6.9 | 3.5 | 2.4 | A | NA | NA | 7.6 | B | 4.2 | 7.2 | A | 0.7 |
| 25 | S | 1.7 | 2.7 | A | Nil | S | AA | 7.3 | 3.1 | 2.3 | P | 2.6 | 3.2 | 6.9 | B | 4 | 4.1 | A | 1.2 |
| 26 | S | 1.9 | 2.6 | A | Nil | S | AA | 7.2 | 3.1 | 2.2 | P | 2.2 | 3.1 | 6.1 | B | 4.1 | 4.3 | A | 1.3 |
| 27 | S | 2 | 3.3 | B | Nil | US | LNA | 8.2 | 3.2 | 3 | P | 2.3 | 3.2 | 7.5 | C | 2.6 | 7 | A | 2.1 |
| 28 | S | 2.2 | 3.1 | A | Nil | US | AA | 8 | 3.4 | 3.1 | A | NA | NA | 7.5 | C | 1.4 | 7.2 | A | 2.1 |
| 29 | CLF | 3.2 | 2.6 | B | PM | US | LNA | 7.3 | 3.5 | 2.8 | A | NA | NA | 4.1 | B | 2.1 | 5.6 | A | 0.9 |
| 30 | S | 2.1 | 2.8 | B | Nil | US | LNA | 7.3 | 3.6 | 2.6 | A | NA | NA | 4.2 | B | 0.8 | 5.5 | A | 1.2 |
| 31 | S | 4.7 | 2.9 | A | B | US | AA | 8 | 3.5 | 2.2 | P | 2.6 | 3 | 5.5 | C | 1.7 | 4.5 | A | 1.7 |
| 32 | S | 1.6 | 2.8 | A | Nil | US | AA | 8.1 | 3.1 | 2.3 | P | 2.4 | 3.2 | 5.7 | C | 1.8 | 4.3 | A | 1.8 |
| 33 | S | 1.9 | 3.2 | A | Nil | US | AA | 8.4 | 3.3 | 2.1 | A | NA | NA | 4.5 | B | 2 | 5 | A | 1.5 |
| 34 | S | 1.5 | 3.1 | A | PM | US | AA | 8.6 | 3.7 | 2.2 | A | NA | NA | 4.4 | B | 2.1 | 5.2 | A | 1.6 |
| 35 | S | 1.3 | 3 | A | Nil | S | AA | 7 | 3.4 | 2.6 | P | 2 | 3 | 6.7 | B | 1.5 | 6.8 | A | 2.1 |
| 36 | CLF | 1.5 | 3.2 | A | Nil | S | AA | 7.1 | 3.2 | 2.8 | P | 3.1 | 3.1 | 6.6 | B | 1.5 | 6.6 | A | 2.2 |
| 37 | S | 1.7 | 2.8 | B | PM | US | LNA | 6.7 | 3.1 | 3.3 | A | NA | NA | 5.5 | B | 2.2 | 5.4 | A | 0.9 |
| 38 | S | 1.4 | 2.6 | B | B | US | LNA | 6.8 | 3.1 | 3.1 | A | NA | NA | 5.6 | B | 2.1 | 5.3 | A | 1.3 |
| 39 | S | 1.4 | 2.9 | A | Nil | US | AA | 7.2 | 3.5 | 3.4 | P | 2.1 | 3.2 | 4.1 | C | 0.9 | 6 | A | 2.1 |
| 40 | S | 2 | 2.8 | B | B | US | LNA | 7.2 | 3.6 | 3.5 | P | 3.1 | 3 | 4 | B | 1.8 | 6.1 | A | 2.3 |
| 41 | S | 1.8 | 2.7 | A | Nil | S | AA | 9 | 3.5 | 2.2 | P | 3.2 | 3.2 | 6 | B | 2.2 | 8 | A | 1.2 |
| 42 | S | 1.5 | 2.5 | A | Nil | S | AA | 8.8 | 3.5 | 2.2 | P | 3.2 | 3.1 | 5.8 | B | 2.3 | 8.2 | A | 1.3 |
| 43 | S | 1.6 | 2.6 | A | Nil | S | AA | 7.3 | 3.3 | 3 | P | 3.3 | 3 | 4.3 | C | 1.8 | 6.3 | A | 1.1 |
| 44 | CLF | 2.1 | 2.7 | A | Nil | S | AA | 7.2 | 3.2 | 3.3 | P | 3.2 | 3.1 | 3.9 | C | 1.9 | 6.4 | A | 1.1 |
| 45 | CLF | 2 | 3.1 | B | PM | US | LNA | 7.4 | 3.6 | 3.4 | A | NA | NA | 5.4 | B | 2.6 | 4.5 | A | 0.9 |
| 46 | S | 1.4 | 3.2 | A | PM | US | AA | 7.2 | 3.4 | 3.5 | A | NA | NA | 5.6 | B | 2.7 | 4.8 | A | 1.1 |
| 47 | S | 1.3 | 3.2 | A | Nil | S | AA | 6.7 | 3.3 | 3.2 | A | NA | NA | 6.3 | B | 2.5 | 5.2 | A | 2 |
| 48 | S | 1.2 | 3.3 | A | Nil | S | AA | 6.5 | 3.4 | 3.3 | A | NA | NA | 6 | B | 2.9 | 5.3 | A | 2.1 |
| 49 | S | 1.1 | 2.8 | A | Nil | S | AA | 6.6 | 3.3 | 3.1 | P | 3.2 | 3.2 | 7.5 | B | 1.2 | 7.5 | A | 1.5 |
| 50 | S | 1 | 2.9 | A | Nil | S | AA | 6.5 | 3.1 | 3.3 | P | 3.3 | 3.1 | 7.4 | B | 1.4 | 7.6 | A | 1.6 |

A-ABOVE ORAL COMMISSURE C-CORRESPONDING TO ORAL COMMISSURE B-BELOW ORAL COMMISSURE

S-SYMMETRICAL US -UNSYMMETRICAL